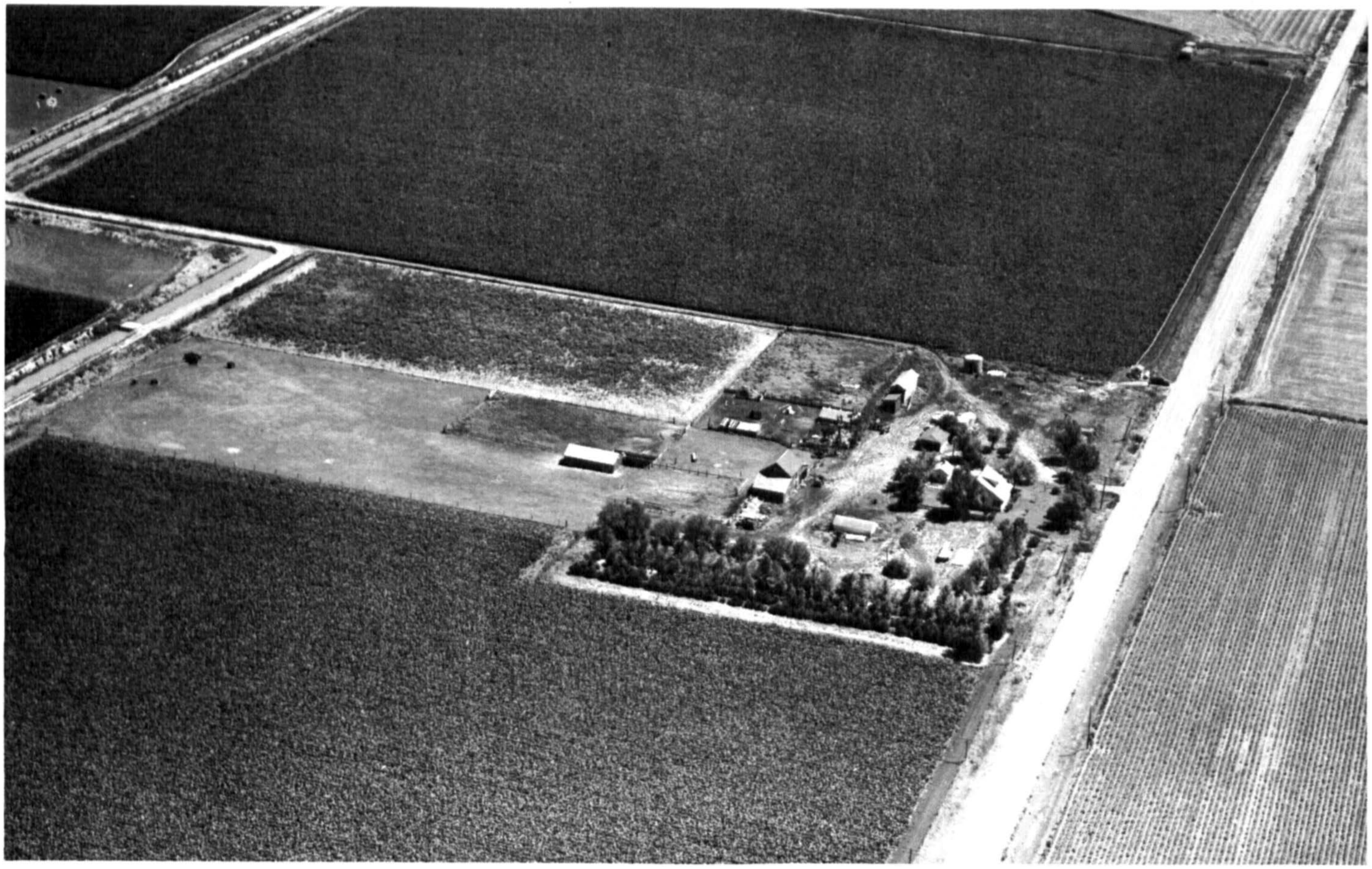
SOIL SURVEY OF

Phelps County, Nebraska



United States Department of Agriculture
Soil Conservation Service
In cooperation with
University of Nebraska
Conservation and Survey Division

Issued 1973

Major fieldwork for this soil survey was done in the period 1958-1963. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Phelps County Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Phelps County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" at the back of this survey can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site and windbreak suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same suitability or limitation. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and windbreak suitability groups.

Foresters and others can refer to the section "Managing the Soils for Woodland and Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Managing the Soils for Wildlife and Recreation."

Ranchers and others can find, under "Managing the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers, builders, and community planners can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Phelps County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County" at the end of the publication.

Cover picture: The Holdrege soils on this farm are irrigated with water from the Tri-County canal. (Photo courtesy Richard Hufnagle).

CONTENTS

SOIL SURVEY OF PHELPS COUNTY, NEBRASKA

BY GILBERT A. BOWMAN, LARRY G. RAGON, CHARLES L. HAMMOND, LAURENCE E. BROWN,

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CONSERVATION AND SURVEY DIVISION

PHELPS COUNTY is located in south-central Nebraska (fig. 1) and has a land area of 545 square miles, or 348,800 acres. It consists mainly of a broad loess upland plain, which is deeply dissected in the southwestern part of the county. The Platte River defines the northern boundary, and the valley of the Platte River includes bottom land and terraces. Much of the northeastern and north-central parts of the county is a hummocky sandy to loamy area.

Holdrege is the county seat. The other principal towns are Bertrand, Loomis, Funk, and Atlanta. The county is mainly a farming area. More than 70 percent is cropland, about one-third of which is irrigated. About 20 percent of the county is in pasture or range, and less than 1 percent is woodland and shelterbelts. Corn, wheat, sorghum, and alfalfa are the principal crops, and rye, oats, barley, soybeans, and sugar beets are minor crops. Growing of crops is the leading farm enterprise, and next most important is the raising of beef cattle and swine. Much of the corn, sorghum, and alfalfa is fed to the livestock. Slightly less than 10 percent of the county is in roads, canals, towns, and other structures or is used for purposes that complement agriculture.

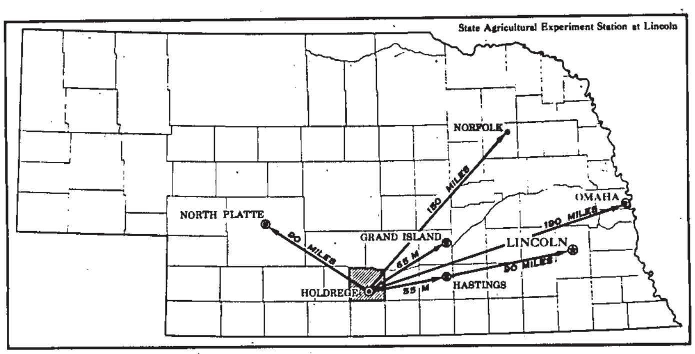


Figure 1.--Location of Phelps County in Nebraska.

Pioneers traveling the Oregon Trail crossed the northern part of the county as early as 1832. A Pony Express route across the county just south of the Platte River was operative in 1861-65. By setting fire to the prairie grass, Indians harvested buffalo from the county as late as the 1870's.

The soils, water supply, climate, and people of Phelps County combine to make this an excellent agricultural area. Yields of crops now grown in the county can be increased through irrigation of larger acreages, better soil management, and planting of improved strains. Other crops could be grown profitably because the soils and climate are suited to a wide variety of crops, and water for irrigation is generally available. Range and livestock feeding are important farm enterprises and give balance to the total agricultural economy.

Soil scientists made this survey to learn what kinds of soils are in Phelps County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Holdrege and Kenesaw, for example, are the names of two soil series. In the United States all soils having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Holdrege silt loam, 3 to 7 percent slopes, is one of several phases within the Holdrege series, which has a slope range of 0 to 10 percent in this county.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Phelps County: soil complexes, and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils joined by a hyphen, for example, the Platte-Wann complex.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Kenesaw and Coly silt loams is an example.

In most areas surveyed, there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Loamy alluvial land is a land type in Phelps County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined management practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

The general soil map at the back of this survey shows, in color, the soil associations in Phelps County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare soils in different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, drainage, or other characteristics that affect their use and management.

The seven soil associations in Phelps County are described on the following pages. The terms for texture in the descriptive heading of each soil association apply to the surface layer. For example, the work "silty" in the descriptive heading for the Holdrege association refers to the texture of the surface layer.

1. Holdrege Association

Deep, Nearly Level to Moderately Sloping, Silty Soils; on Uplands

This association occurs as a broad belt that extends from northwest to southeast across the upland. All the soils of this association formed in a thick deposit of loess (fig. 2). Where the landscape is nearly level to very gently sloping, the drainage pattern is poorly defined, and the shallow depressions often contain ponded water. Where the landscape is gently sloping to moderately sloping, the drainage pattern is well defined.

This association occupies 55 percent of the county. Holdrege soils make up 94 percent of it. Butler, Crete, Detroit, Hord, and Scott soils and Marsh constitute the remaining 6 percent.

Holdrege soils are deep and nearly level to moderately sloping. They have a silt loam surface layer, a light silty clay loam subsoil, and silt loam underlying material.

Butler soils are nearly level and are in flats and shallow depressions. Crete, Detroit, and Hord soils are nearly level and at a slightly lower elevation than Holdrege soils. Scott soils are in well-defined depressions, and Marsh occupies the lowest, wettest parts of these depressions.

Most of this association is suited to cultivated crops. A plentiful supply of water is available from wells and canals, and much of the cropland is irrigated. Dryfarming also is important. Farms range from 160 to 640 acres in size and are used mainly for cash grain. Most of them are located along gravelled section-line roads that provide access to markets. Loss of fertility and erosion of sloping soils are the principal concerns in management.

2. Coly-Holdrege Association

Deep, Gently Sloping to Steep, Silty Soils; on Uplands

This association occurs on gently sloping ridges and on moderately steep to steep side slopes of drainageways and canyons. The soils of this association formed in a thick deposit of loess (fig. 3). They are drained by Spring and Elm Creeks, which flow southward out of the county.

The Coly-Holdrege association occupies about 15 percent of the county. Coly soils make up 50 percent of the association and Holdrege soils 40 percent. Butler, Hord, and Hobbs soils and Rough broken land, loess, constitute the remaining 10 percent.

Coly soils are on the steepest sides of the drainageways. Their thin surface layer is silt loam. The underlying material is calcareous silt loam. These soils are lighter colored and less well developed than any other soils in the county, except for some that formed in alluvium.

Holdrege soils are on ridges that are remnants of an upland plain. They are deep, well developed, and gently sloping. Their surface layer is thick and of silt loam texture. The subsoil is a dominantly light silty clay loam, and the underlying material is a silt loam of lighter color.

Butler soils occur in a few small and shallow depressions on the upland plain. Rough broken land, loess, is on the steep and very steep sides of the canyonlike drainageways. Hord soils are on the stream terraces along Spring and Elm Creeks, and Hobbs soils formed on bottom lands in the narrow canyons.

Most of the gently sloping to moderately sloping areas in this association are dryfarmed. Only a small acreage is irrigated. The rest is used mainly for range, primarily for beef cattle. Most farms are diversified. They average about 640 acres, but some are as large as 2,000 acres. Gravel roads are on some, but not all, section lines. Farmers have few problems in getting their products to market. Their main concerns are controlling surface runoff, erosion, and soil blowing. Proper management practices are needed on rangeland.

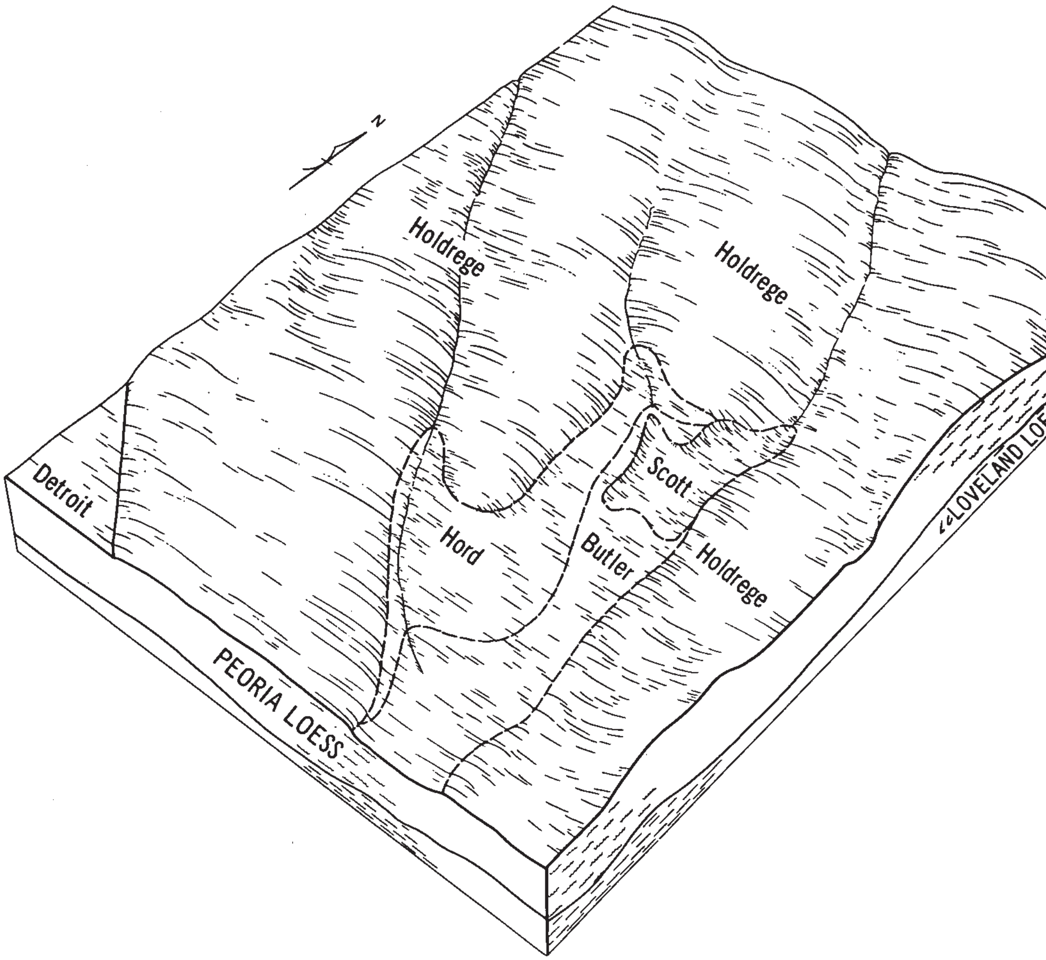


Figure 2.--Pattern of soils and underlying materials in the Holdrege associati

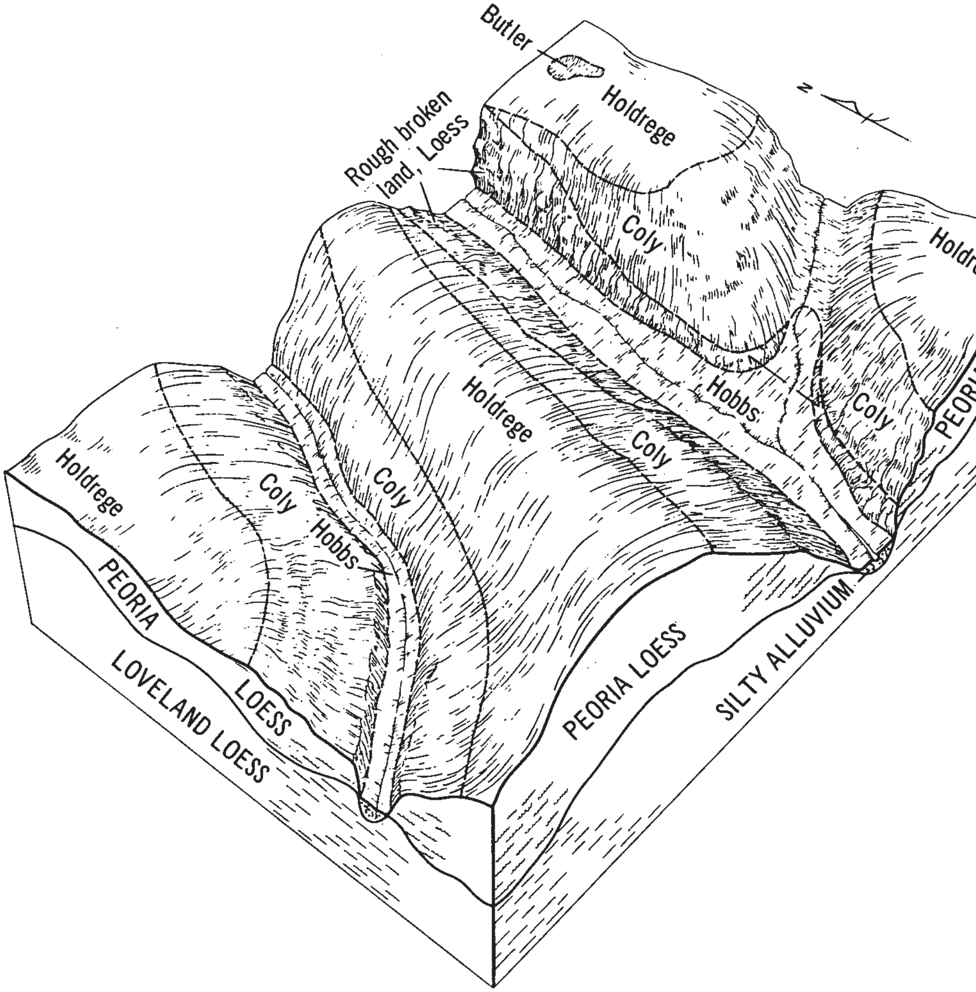


Figure 3.--Pattern of soils and underlying materials typical of the Coly-Holdrege

3. Kenesaw-Anselmo Association

Deep, Nearly Level to Moderately Sloping, Loamy Soils; on Uplands

This association occurs in an area of low hummocks on the uplands (fig. 4). The area has been affected by soil blowing. The largest hummocks and the coarsest soils are in the northern part of the association. Drainage patterns are fairly well defined over most of this association. In places, however, water ponds in small basins for short periods.

This association occupies 15 percent of the county. Kenesaw soils make up about 75 percent of it, and Anselmo soils about 20 percent. Where these soils are in the same landscape, the Kenesaw soils are at the lower elevations. The remaining 5 percent of the association consists of Valentine and Rusco soils.

Kenesaw soils are deep and well drained. They formed in loess, and both the surface layer and the underlying material are silt loam.

Anselmo soils also are deep and well drained. They have a fine sandy loam surface layer and subsoil and a loamy sand underlying material.

Valentine soils occupy the largest hummocks and some sandhill areas. Rusco soils are in shallow depressions.

Soils in this association are used mainly for cultivated crops. Some small areas are in range. Only a few isolated acreages are irrigated. Sprinkler systems have a potential for increasing production of both cultivated crops and range.

Most farms range from 480 to 800 acres in size, but some are as large as 2,000 acres. Gravel or graded dirt roads are on nearly all section lines and provide easy access to markets. Soil blowing and the droughty nature of the soils are concerns in cultivated areas. Proper range management is needed on grasslands.

4. Valentine-Anselmo Association

Deep, Nearly Level to Strongly Sloping, Sandy and Loamy Soils; on Uplands

This association is nearly level to gently undulating or hilly (fig. 5) and occurs on uplands. The soils formed in wind-deposited sand and silty sand. The drainage pattern is poorly defined because the soils absorb rain about as rapidly as it falls, and runoff is slight.

This association occupies 6 percent of the county. Valentine soils constitute about 75 percent of the association, and Anselmo soils about 15 percent. Kenesaw soils make up the remaining 10 percent.

Valentine soils are deep and loose. Their surface layer is loamy sand, and the underlying material is fine sand.

Anselmo soils have a fine sandy loam or very fine sandy loam surface layer and a fine sandy loam subsoil that grades downward to underlying loamy sand.

Kenesaw soils have a lower elevation than Valentine or Anselmo soils.

Soils in this association are used almost entirely for range. A few broad low-lying areas are used for irrigated row crops. Sprinkler irrigation systems have potential for increasing crop production. Ranching is the most common type of agriculture, and the size of ranches ranges from 1,000 to 2,500 acres. Gravel or improved dirt roads are on most, but not all, section lines. The main concerns are soil blowing, the droughty nature of the soils, and range management.

5. Meadin-Anselmo-O'Neill Association

Nearly Level to Very Gently Sloping, Loamy and Sandy Soils that are Shallow to Deep over Sand and Gravel; on Terraces

This association occurs on a long, narrow stream terrace within the Platte River valley. The landscape is nearly level to very gently sloping (fig. 5).

This association occupies about 2 percent of the county. Meadin soils constitute about 50 percent of the association. Anselmo soils 25 percent, and O'Neill soils 18 percent. Thurman and Valentine soils make up the remaining 7 percent.

Meadin soils have a silt loam or loamy sand surface layer and are shallow over mixed sand and gravel.

Anselmo soils are deep and have a fine sandy loam surface layer and subsoil and loamy sand underlying material.

O'Neill soils have a fine sandy loam surface layer and a sandy loam subsoil. They are moderately deep over mixed sand and gravel.

Thurman and Valentine soils are adjacent to the bottom land along the Platte River. They are slightly higher in elevation than the O'Neill and Meadin soils.

The soils best suited to farming are cultivated and irrigated; the shallow, more droughty soils remain in native grass. Water from wells is available for irrigation. Most farms include land in adjacent associations and are diversified. Their size ranges from 160 to 640 acres. Good gravel and improved dirt roads are on most section lines. The main concerns are soil blowing, the droughty nature of some soils, and water management for efficient irrigation. Proper range management is needed on native grasslands.

6. Hord Association

Deep, Nearly Level, Silty Soils; on Terraces

This association consists of soils on silty stream terraces within the Platte River valley in

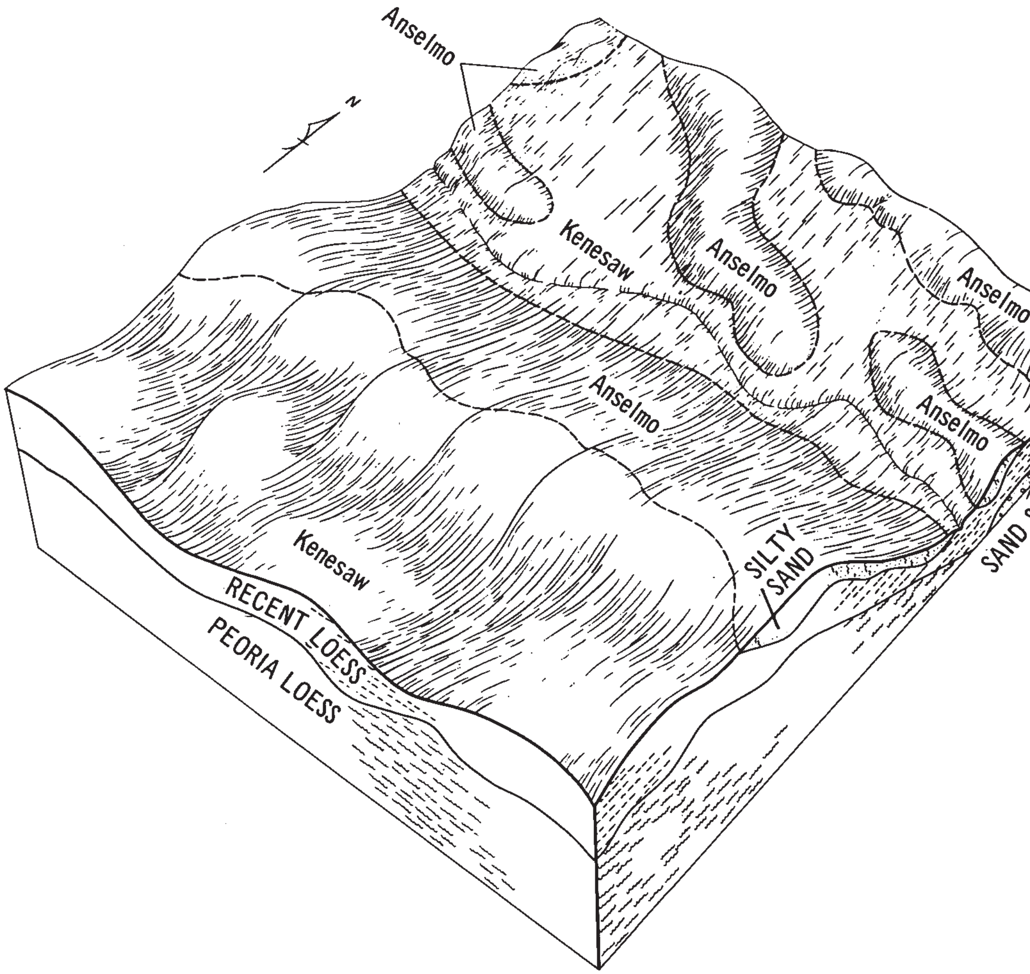


Figure 4.--Pattern of principal soils and underlying materials in the Kenesaw-Anselmo association.

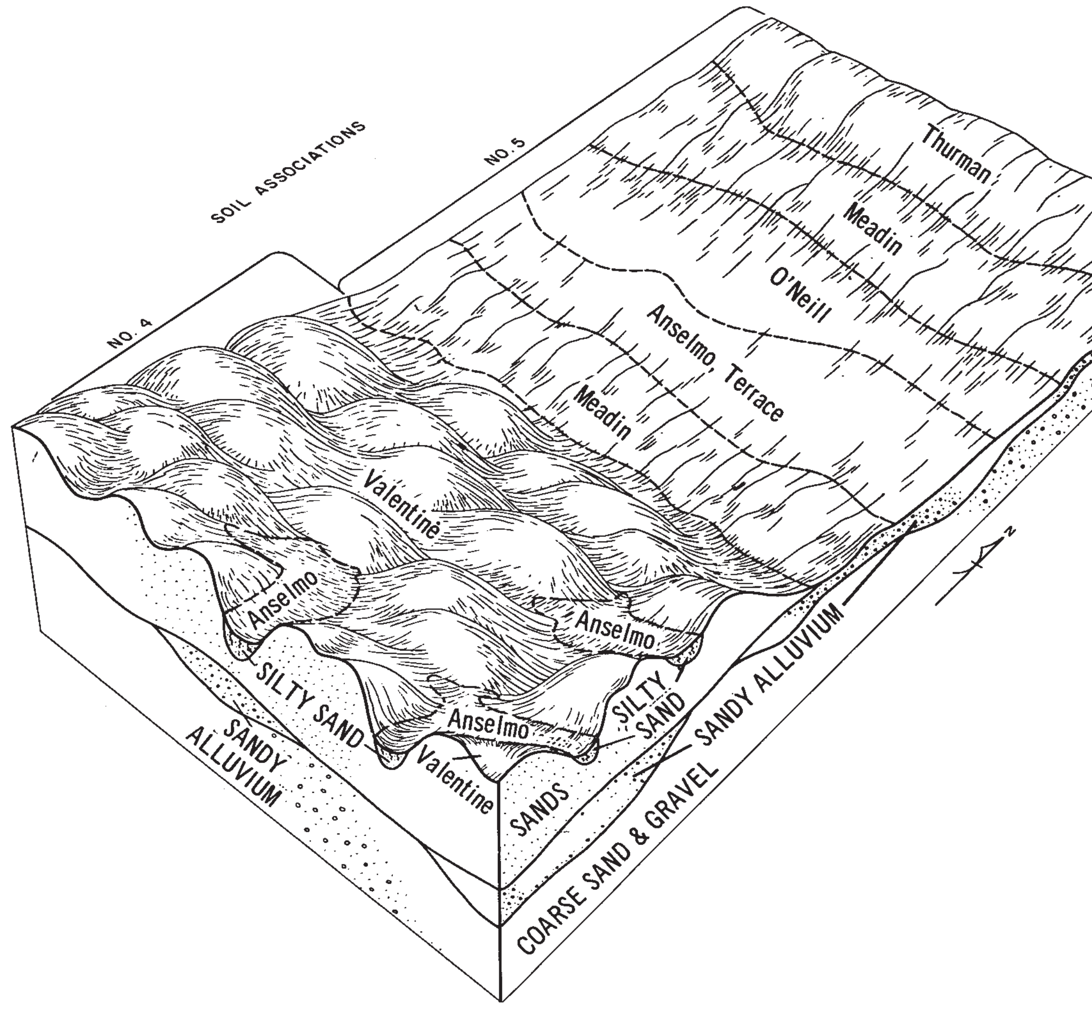


Figure 5.--Principal soils and underlying materials in the Valentine-Ansel
and Meadin-Anselmo-O'Neill associations.

the northwestern part of the county. The landscape is nearly level except where drains from the uplands on the south have cut into the terraces.

This association occupies about 2 percent of the county. Hord soils constitute 95 percent of the association, and Kenesaw and Coly soils make up the remaining 5 percent.

Hord soils have a thick silt loam surface layer, a heavy silt loam subsoil, and silt loam underlying material.

Kenesaw soils are at slightly higher elevations than Hord soils. Coly soils are on the side slopes of intermittent drains that cross the terraces.

This association is used mainly for irrigated crops. Water is plentiful for irrigation. A small acreage is in dryfarmed wheat and alfalfa. The farms range from 160 to 640 acres in size. They are mainly of the cash-grain type, but some are diversified and include rangeland in adjacent associations. Good gravel roads are on most section lines. The principal concerns are management of irrigation water, soil blowing, and maintaining fertility.

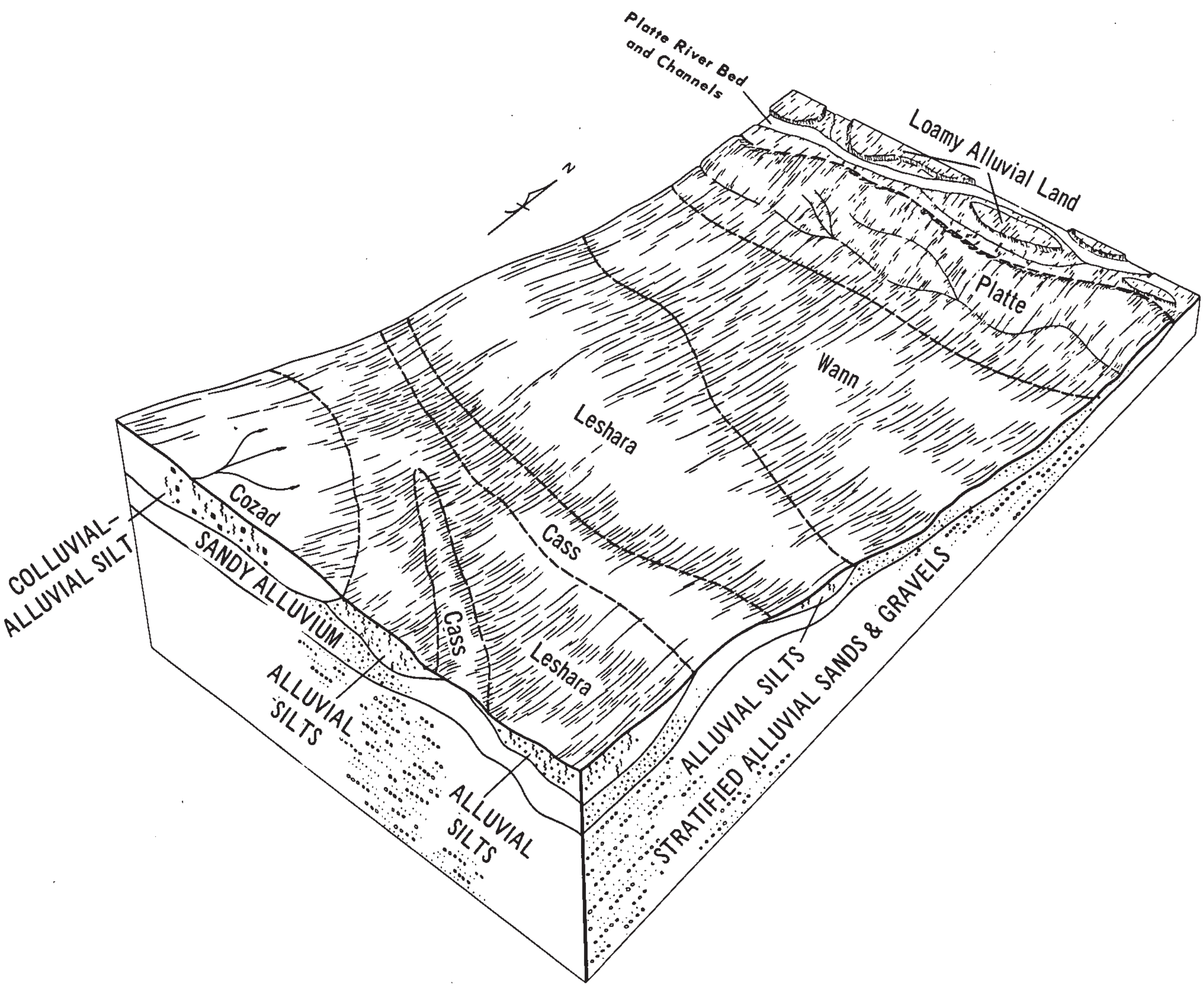


Figure 6.--Pattern of soils and underlying materials in the Leshara-Wann association.

7. Leshara-Wann Association

Nearly Level, Loamy Soils that are Deep and Moderately Deep over Sand and Gravel; on Bottom Lands

This association occurs on narrow bottom lands along the Platte River, which forms the north boundary of the county. The landscape is nearly level (fig. 6, p. 9). Depth to the water table ranges from 2 to 6 feet. In places, the soils are saline or alkaline.

This association occupies about 5 percent of the county. Leshara soils make up about 42 percent of the association, and Wann soils about 35 percent. Cass, Platte, Grigston, and Cozad soils, Marsh, and Loamy alluvial land constitute the remaining 23 percent.

Leshara soils are deep and somewhat poorly drained. The surface layer is silt loam, and the underlying material is silt loam that grades downward to mixed sand and gravel at a depth of 40 to 60 inches.

Wann soils are deep and moderately deep and somewhat poorly drained. The surface layer is loam, and the underlying material is sandy loam. Mixed sand and gravel generally is below a depth of 5 feet.

Cass, Grigston, and Cozad soils occupy the slightly higher, better drained areas within the association. Platte soils, Loamy alluvial land, and Marsh are on the lowest parts of the landscape, in most instances adjacent to channels of the Platte River.

Most of this association is cultivated, but areas adjacent to the river are in native range. Some crops are dryfarmed, and some are irrigated. Farms range from 160 to 480 acres in size. Although used mainly for cash grain, most farms have some cattle on the range. As gravel roads are on many, but not all, section lines, farmers have easy access to markets. The principal concerns are soil blowing, efficient management of irrigation water, and maintaining fertility. Proper range management practices are needed on the grasslands.

DESCRIPTIONS OF THE SOILS

This section describes the soil series and mapping units in Phelps County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series is described. Unless specifically mentioned otherwise, what is stated about the soil series can be assumed to hold true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, the sequence of layers from the surface downward to a depth of 60 inches. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless otherwise stated, the colors given in the descriptions are those of a dry soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Loamy alluvial land, for example, does not belong to any soil series, but nevertheless is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page for the description of each capability unit, range site, and windbreak suitability group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (3) 1/.

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Such differences in name result from changes in the concepts of soil classification that have occurred since publication. The characteristics of the soil series described in this county are considered to be within the range defined for that series. In those instances where a soil series has one or more features outside the defined range, the differences are explained.

Anselmo Series

The Anselmo series consists of deep, nearly level to moderately sloping, well-drained soils that formed in material deposited by wind. These soils occur on uplands and stream terraces in the northeastern part of the county. Some areas are hummocky.

In a representative profile, the surface layer is fine sandy loam about 8 inches thick. The upper part is pale brown, and the lower part is brown. The subsoil is fine sandy loam about 22 inches thick; it is brown in the upper part and pale brown in the lower part. The underlying material, which extends

1/ Underscored numbers in parentheses refer to Literature Cited, p. 85.

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Soil	Area	Extent	Soil	Area	Extent
	Acres	Percent		Acres	Percent
Anselmo fine sandy loam, 0 to 3 percent slopes	1,138	0.3	Holdrege silt loam, 7 to 10 percent slopes	1,730	0.5
Anselmo fine sandy loam, hummocky	606	.2	Holdrege soils, 3 to 7 percent slopes, severely eroded	1,585	.4
Anselmo fine sandy loam, hummocky, eroded	1,961	.6	Holdrege-Coly complex, 7 to 10 percent slopes, eroded	3,118	.9
Anselmo fine sandy loam, 7 to 10 percent slopes	774	.2	Hord silt loam	2,690	.8
Anselmo fine sandy loam, terrace, 0 to 3 percent slopes	915	.3	Hord silt loam, terrace	5,261	1.5
Anselmo very fine sandy loam, 0 to 1 percent slopes	199	.1	Kenesaw silt loam, 0 to 1 percent slopes	20,347	5.8
Anselmo very fine sandy loam, terrace, 0 to 1 percent slopes	184	.1	Kenesaw silt loam, terrace, 1 to 3 percent slopes	10,767	3.1
Butler silt loam	2,155	.6	Kenesaw and Coly silt loams, hummocky	1,596	.5
Butler silt loam, depressional	3,330	.9	Kenesaw and Coly silt loams, hummocky, eroded	5,114	1.5
Cass fine sandy loam	340	.1	Leshara silt loam	3,788	1.2
Coly silt loam, 10 to 30 percent slopes	23,500	6.7	Leshara silt loam, saline	2,840	.8
Coly and Kenesaw silt loams, 7 to 10 percent slopes	891	.3	Loamy alluvial land	661	.2
Cozad silt loam	1,391	.4	Marsh	1,580	.4
Crete silt loam	2,580	.7	Meadin loamy sand, terrace, 0 to 2 percent slopes	1,900	.5
Detroit silt loam	2,323	.7	Meadin silt loam, terrace, 0 to 1 percent slopes	101	(1/)
Grigston silt loam	450	.1	O'Neill fine sandy loam, 0 to 1 percent slopes	850	.2
Hobbs silt loam	450	.1	Platte soils	504	.1
Hobbs silt loam, overwash	536	.2	Platte-Wann complex, channeled	336	.1
Holdrege silt loam, 0 to 1 percent slopes	147,244	42.2	Rough broken land, loess	6,082	1.7
Holdrege silt loam, 1 to 3 percent slopes	34,423	9.9	Rusco silt loam	318	.1
Holdrege silt loam, 1 to 3 percent slopes, eroded	12,040	3.4	Scott silt loam	4,253	1.4
Holdrege silt loam, 3 to 7 percent slopes	1,739	.5	Spoil banks	852	.2
Holdrege silt loam, 3 to 7 percent slopes, eroded	11,456	3.3	Thurman loamy fine sand, terrace, 0 to 3 percent slopes	219	.1
			Valentine loamy sand	15,295	4.4
			Wann fine sandy loam	889	.2
			Wann loam	4,193	1.2
			Wann loam, saline	652	.2
			Total	348,800	100.0

1/ Less than 0.05 percent.

from a depth of 30 inches down to 60 inches, is pale-brown loamy sand.

Anselmo soils have moderate available water capacity and moderately rapid permeability. They have moderately low organic-matter content and medium natural fertility. Reaction is neutral in the surface layer and subsoil and mildly alkaline in the underlying material.

Anselmo soils are well suited to cultivation and respond well to irrigation. They are also suited to pasture and range grasses and to windbreaks. They provide habitat for wildlife. Some acreage is still in native grass. These are good soils for farming but are subject to soil blowing.

Representative profile of Anselmo fine sandy loam, hummocky, 0.25 mile east of the southwest corner of sec. 1, T. 7 N., R. 17 W., in native range:

A11--0 to 2 inches, pale-brown (10YR 6/3) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft,

very friable; neutral; abrupt, smooth boundary.

A12--2 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to weak, medium, blocky structure; soft, very friable; neutral; clear, smooth boundary.

B2--8 to 16 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; moderate, coarse, prismatic structure parting to weak, medium, blocky structure; soft, very friable; neutral; gradual, smooth boundary.

B3--16 to 30 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) when moist; weak, coarse, prismatic structure; soft, very friable; neutral; gradual, smooth boundary.

C--30 to 60 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 4/3) when moist; single grained; loose; mildly alkaline.

The A horizon is very fine sandy loam or fine sandy loam and ranges from 7 to 20 inches in thickness. The B horizon is light, very fine sandy loam or fine sandy loam. The C horizon commonly is stratified fine sandy loam to loamy sand.

Anselmo soils are associated with Kenesaw, Thurman, and Valentine soils. They contain more sand than Kenesaw soils, are not so coarse as Thurman or Valentine soils, and have a thicker A horizon than Valentine soils.

Anselmo fine sandy loam, 0 to 3 percent slopes (AnA).--This is a nearly level to very gently sloping soil of the uplands that formed in moderately coarse wind-deposited material. Included with it in mapping were a few small areas of Kenesaw silt loam, 0 to 1 percent slopes.

Surface runoff is slow, and much of the rainfall is absorbed. Soil blowing is a hazard where the soil is not adequately protected. Maintenance of fertility, efficient use of water, and loss of water by deep percolation are the main concerns where the soil is irrigated. The soil is easily worked.

Most of the acreage is cultivated. The principal crops are corn, wheat, alfalfa, and grain sorghum. Less common crops are rye and oats. Some acreage is still in range. Trees are grown successfully in windbreaks and provide habitat for wildlife. (Capability units IIe-3 dryland and IIe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Anselmo fine sandy loam, hummocky (3 to 7 percent slopes) (AnB).--This is an uneven, gently undulating soil that has short slopes. Its profile is the one described as representative of the series. Included in mapping were small areas of Kenesaw silt loam, 0 to 1 percent slopes, of Anselmo fine sandy loam, 0 to 3 percent slopes, and of Kenesaw and Coly silt loams, 1 to 3 percent slopes.

Surface runoff is slow because much of the rainfall is absorbed almost as quickly as it falls. Soil blowing is one of the main hazards where this soil is cultivated. The soil can be droughty, and it has a low potential for sustained production when dryfarmed. It responds well to irrigation, but maintaining fertility and selecting the proper method of applying water are necessary. Gravity irrigation is practical only if considerable land reshaping is done.

Most areas of this soil are still in native range. Where this soil is cultivated, the best suited crops are wheat, corn, grain sorghum, and alfalfa. Trees are successfully grown in windbreaks. This soil also provides habitat for wildlife. (Capability units IIIe-3 dryland and IIIe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Anselmo fine sandy loam, hummocky, eroded (3 to 7 percent slopes) (AnB2).--This is a gently undulating soil having short slopes. Its profile is similar to that described as representative of the series, except that the surface layer is thinner. In places where erosion has been severe, the surface layer is lighter colored than that in the representative profile. Included in mapping were areas where the surface layer is loamy fine sand and small areas of Kenesaw silt loam, 0 to 1 percent slopes.

Soil blowing is the main hazard where this soil is cultivated. Where dryfarmed this soil tends to be droughty because the available water capacity is in the low part of the medium range. The soil is suited to irrigation. Crops respond well to fertilizer.

Corn, wheat, alfalfa, and grain sorghum are the main cultivated crops on this soil, which also is suited to both pasture and range grasses. Trees are successfully grown in windbreaks. The soil provides habitat for wildlife. (Capability units IIIe-3 dryland and IIIe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Anselmo fine sandy loam, 7 to 10 percent slopes (AnC).--This soil is rolling and has short slopes. Included in mapping were small areas of Valentine loamy sand. Also included were a few small areas having a surface layer of loamy fine sand and some cultivated areas having a lighter colored surface layer than this soil.

Soil blowing is the main hazard where this soil is cultivated. Surface runoff is slow because much of the rain is absorbed where it falls. The organic-matter content is moderately low in cultivated areas. The soil is suited to dry farming but is droughty. Crops respond well to fertilizer, which is necessary for sustained productivity.

Most of the area is in native range. Irrigation has not been widely used, because of the problems in distributing and applying water. Windbreaks consisting of woody plantings are grown successfully. Areas of this soil provide protection and food for wildlife. (Capability units IVe-3 dryland and IVe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Anselmo fine sandy loam, terrace, 0 to 3 percent slopes (2AnA).--This soil is nearly level to very gently sloping. It has a profile similar to the one

described as representative of the series, except that mixed sand and gravel occur at depths of 4 to 6 feet. In places the surface layer is eroded and light colored. Included in mapping were small areas of Meadin loamy sand, terrace, 0 to 2 percent slopes, and Valentine loamy sand.

Soil blowing is the main hazard where this soil is cultivated. Where dryfarmed, this soil is somewhat droughty. The natural fertility is medium. Fertility maintenance is important, particularly if the soil is irrigated. Plant nutrients can be leached below rooting depths because the subsoil is moderately rapidly permeable and the underlying material is rapidly permeable. Crops respond well to fertilizer. Surface runoff is slow.

This soil is suited to growing all crops common in the county. Corn, alfalfa, and grain sorghum are the main crops. Nearly all the acreage is cultivated, and most is irrigated. This soil is suited to trees and grasses, and it provides habitat for upland wildlife. (Capability units IIe-3 dryland and IIe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Anselmo very fine sandy loam, 0 to 1 percent slopes (Ag).--This nearly level soil of the uplands formed in wind-deposited material. It is lower in elevation than surrounding soils. Its profile is similar to the one described as representative of the series, but the surface layer is finer textured and darker colored. In places the very fine sandy loam material is 18 to 20 inches thick. Depth to lime ranges from 2 to 5 feet. Included in mapping were some areas where the subsoil is very fine sandy loam, and small areas of Kenesaw silt loam.

Soil blowing is the main hazard when this soil is cultivated. Where dryfarmed, this soil can be droughty during years of below-average rainfall. It is well suited to irrigation. Crops respond well to fertilizer. Surface runoff is slow.

About half the acreage is in native range, and the rest is cultivated. Trees are grown successfully in windbreaks. This soil provides food and cover for upland wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Sandy range site; Silty to Clayey windbreak suitability group)

Anselmo very fine sandy loam, terrace, 0 to 1 percent slopes (2Ag).--This nearly level soil is on stream terraces in the Platte River valley. Its profile is similar to the one described as representative of the series, except the surface layer is finer textured, and mixed sand and gravel is 4 to 6 feet from the surface. Included in mapping were small areas of Thurman loamy fine sand and Anselmo fine sandy loam.

Soil blowing and susceptibility to drought are the main hazards where this soil is cultivated. The soil is well suited to irrigation and is easily worked. Maintaining fertility and efficient management of water are concerns where the soil is irrigated. Because the underlying material is coarse-textured, leaching of plant nutrients is possible where the soil is overirrigated.

This soil is suited to all the crops commonly grown in the county. Grasses and trees grow well, and this soil provides habitat for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Sandy range site; Silty to Clayey windbreak suitability group)

Butler Series

The Butler series consists of deep, nearly level soils that formed in loess. These soils occur on flats and in shallow depressions on uplands and are somewhat poorly drained.

In a representative profile, the surface layer is dark-gray silt loam about 8 inches thick. The subsurface layer is gray silt loam about 6 inches thick. The subsoil, about 22 inches thick, is dark-gray, very firm silty clay in its upper part; grayish-brown, very firm silty clay in its middle part; and pale-brown, firm silty clay loam in its lower part. Beneath the subsoil is silt loam that grades from very pale brown to light gray. The surface layer is slightly acid, and the subsoil and underlying material are neutral.

Butler soils have a high available water capacity and slow permeability. They have moderate organic-matter content and high natural fertility. Where dryfarmed, they are sometimes droughty because only the surface layer and subsurface layer effectively store moisture. The claypan subsoil limits movement of moisture and, particularly when dry, restricts penetration by roots.

Butler soils are suited to cultivated crops and respond well to irrigation. They are also suited to pasture grasses and windbreaks, and they provide habitat for wildlife.

Representative profile of Butler silt loam, depressional, 30 feet east and 0.4 mile north of the southwest corner of sec. 24, T. 6 N., R. 20 W., in a cultivated field:

Ap--0 to 4 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, fine, crumb structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A1--4 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, medium and fine, granular structure; hard, friable; slightly acid; clear, smooth boundary.

A21--8 to 12 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; moderate, coarse, blocky structure; slightly hard, friable; slightly acid; clear, smooth boundary.

A22--12 to 14 inches, gray (10YR 6/1) silt loam, dark gray (10YR 4/1) when moist; moderate, coarse, blocky structure; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

B21t--14 to 22 inches, dark-gray (10YR 4/1) silty clay, very dark brown (10YR 2/2) when moist; few, faint, fine, reddish-brown (5YR 5/4) mottles; moderate, coarse, prismatic structure parting to strong, medium and fine, blocky

structure; very hard, very firm; neutral; gradual, smooth boundary.

B22t--22 to 28 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; few, faint, fine, reddish-brown (5YR 5/4) mottles; moderate, coarse, prismatic structure parting to strong, medium and fine, angular blocky structure; very hard, very firm; neutral; clear, smooth boundary.

B3--28 to 36 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; hard, firm; neutral; clear, smooth boundary.

C1--36 to 48 inches, very pale-brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard, friable; neutral; gradual, smooth boundary.

C2--48 to 60 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; massive; slightly hard, very friable; neutral; gradual, smooth boundary.

The A horizon ranges from 10 to 20 inches in thickness, and the B horizon from 14 to 24 inches. The B2t horizon is silty clay or clay. Depth to lime ranges from 30 to 60 inches.

Butler soils are associated with Holdrege, Detroit, Crete, and Scott soils. They have a finer textured B horizon than Holdrege or Detroit soils and have a gray A2 horizon that is lacking in Crete soils. They have a thicker A horizon than Scott soils, and they are not so subject to severe flooding.

Butler silt loam (0 to 1 percent slopes) (Bu).--This soil is nearly level to slightly concave. Its profile is similar to the one described as representative of the series, but its surface layer is about 3 inches thinner, and its depth to lime is less. Included with this soil in mapping were small areas of Detroit silt loam and of nearly level Holdrege silt loam.

Although this soil is deep, it can be droughty where crops are dryfarmed because its surface layer is the only part that effectively stores available moisture. The claypan subsoil limits movement of moisture and, particularly when dry, limits penetration by roots. Surface runoff is slow. Maintaining fertility is a concern where crops are irrigated.

Butler silt loam is used principally for cultivated crops. The most common crops are corn, wheat, and grain sorghum. Pasture, range, and windbreaks occupy a small acreage. This soil also provides habitat for wildlife. (Capability units IIs-2 dryland and IIs-2 irrigated; Clayey range site; Silty to Clayey windbreak suitability group)

Butler silt loam, depressional (0 to 1 percent slopes) (2Bu).--This soil is in shallow depressions. Its profile is the one described as representative of the series in Phelps County. Lime is leached to depths lower than is typical for the Butler series. Included in mapping were small areas of Detroit silt loam and nearly level Holdrege silt loam.

Ponding of runoff from surrounding areas is the primary hazard and causes crop failure once in about 5 years. Most of the ponded water evaporates or slowly infiltrates the subsoil, which becomes very hard on drying. Surface drains are needed where this soil is irrigated.

Nearly all the acreage is cultivated. The most common crops are corn, wheat, and grain sorghum. Alfalfa is less commonly grown because it tolerates only temporary flooding. Windbreaks are grown successfully. This soil also provides cover and food for wildlife. (Capability units IIIw-2 dryland and IIs-21 irrigated; Clayey Overflow range site; Moderately Wet windbreak suitability group)

Cass Series

The Cass series consists of deep, nearly level, well-drained soils that formed in moderately coarse textured and coarse-textured alluvium. These soils are on the higher bottom lands in the Platte River valley.

In a representative profile, the surface layer is 19 inches thick. To a depth of 16 inches it is grayish-brown, fine sandy loam, and the remaining 3 inches is dark grayish-brown, very fine sandy loam. The underlying material is pale-brown, loose sandy loam and loamy fine sand. Lime is at a depth of 41 inches. The surface layer is neutral, and the underlying material is mildly to moderately alkaline. The water table is 5 to 15 feet below the surface.

Cass soils have moderately rapid permeability and moderate available water capacity. They are moderately low in organic-matter content and medium in natural fertility.

Cass soils are suited to cultivated crops and respond well to irrigation. They are also suited to range and windbreaks and provide habitat for wildlife.

Representative profile of Cass fine sandy loam, 195 feet south and 0.1 mile west of the northeast corner of sec. 24, T. 8 N., R. 18 W., in a cultivated field:

Ap--0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft, very friable; neutral; abrupt, smooth boundary.

A11--5 to 16 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

A12--16 to 19 inches, dark grayish-brown (10YR 4/2) light very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

C1--19 to 41 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; single grained; loose; mildly alkaline; clear, smooth boundary.
C2--41 to 48 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; single grained; loose; violent effervescence; moderately alkaline; clear, smooth boundary.
C3--48 to 56 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; single grained; loose; slight effervescence; moderately alkaline; clear, smooth boundary.
C4--56 to 60 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; single grained; loose; strong effervescence; moderately alkaline.

The A horizon ranges from 7 to 20 inches in thickness. In many places the C horizon is stratified with light and dark coarser textured layers. Depth to lime ranges from 30 inches to more than 5 feet, and depth to mixed sand and gravel ranges from 40 inches to about 6 feet.

Cass soils are associated with Leshara and Wann soils and with the terrace phase of Anselmo soils. They have a coarser textured C horizon than Leshara soils. Depth to the water table is greater in Cass soils than in Leshara and Wann soils and less than in the terrace phase of Anselmo soils.

Cass fine sandy loam (0 to 1 percent slopes) (Cs).--This soil is on high bottom lands in the Platte River valley. Included in mapping were small areas of Leshara silt loam, Wann loam, and Wann fine sandy loam.

This soil tends to be droughty when dryfarmed. It is well suited to irrigation, but maintaining fertility generally is difficult. Soil blowing is a hazard unless the surface is protected by a growing crop or crop residue. Surface runoff is slow.

Nearly all the acreage is cultivated, and a large part is irrigated. Wheat, corn, sorghum, and alfalfa are the most common crops. A small acreage is in range and pasture. This soil is suited to windbreaks and provides habitat for wildlife. (Capability units IIe-3 dryland and IIe-3 irrigated; Sandy Lowland range site; Sandy windbreak suitability group)

Coly Series

The Coly series consists of deep, very gently sloping to steep, medium-textured soils on uplands. These soils formed in thick deposits of loess and are well drained.

In a representative profile the surface layer is grayish-brown silt loam 4 inches thick. Beneath this is a 4-inch transition layer of calcareous grayish-brown silt loam. The underlying material, to a depth of at least 60 inches, is light-gray silt loam.

Coly soils have moderate permeability and high available water capacity. They have low organic-matter content and low natural fertility. The surface layer is mildly alkaline and the underlying material is moderately alkaline.

Coly soils are used mainly for growing cultivated crops and for range. They are suited to windbreaks and provide habitat for wildlife.

Representative profile of Coly silt loam, 10 to 30 percent slopes, 75 feet south and 0.2 mile east of the northwest corner of sec. 21, T. 6 N., R. 20 W., in native range:

A1--0 to 4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; slightly hard, very friable; mildly alkaline; clear, smooth boundary.
AC--4 to 8 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; smooth boundary.
C--8 to 60 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure parting to massive; slightly hard, very friable; violent effervescence; moderately alkaline; few, fine, distinct, reddish-brown relict stains; some worm casts present.

The A horizon ranges from 3 to 6 inches in thickness and has a crumb or weak granular structure. The color ranges from grayish brown to very pale brown. The lighter color is in eroded areas or on steep slopes. Depth to lime ranges from less than 1 inch to 10 inches.

Coly soils are associated with Kenesaw and Holdrege soils. They have lime higher in the profile than either Kenesaw or Holdrege soils, and the A horizon is thinner and lighter colored than that of Holdrege soils. Coly soils lack a B horizon, which is present in Holdrege soils.

Coly silt loam, 10 to 30 percent slopes (CbD).--This strongly sloping to steep soil is on the sides of drains and canyons (plate I, top). Included in mapping were small areas of soils that developed in reddish-brown soil material. These soils are present on the lower parts of slopes, in small narrow areas of alluvial land in the bottoms of canyons, and in a few areas of Rough Broken land, loess, where the slopes are broken by soil slippage or "catsteps."

This soil is subject to severe water erosion because runoff is rapid. It is too steep for successful cultivation, and a few areas that have been cultivated are now severely gullied. Areas that have been cultivated can be returned to native grass.

This soil is best suited to range, and nearly all of the acreage is used for this purpose. Windbreaks grow successfully. This soil also provides habitat for wildlife. (Capability unit VIe-9 dryland, not

placed in irrigated capability unit; Limy Upland range site; Silty to Clayey windbreak suitability group)

Coly and Kenesaw silt loams, 7 to 10 percent slopes (CKC).--These soils, which are about 60 percent Coly silt loam and about 40 percent Kenesaw silt loam, are on the sides of well-defined drains. The Coly soil in this mapping unit has a lighter colored surface layer than does the Kenesaw soil. Lime is nearer the surface in the profiles of both soils in this mapping unit than it is in the profile described as representative for the series. Included with these soils in mapping were small areas with slopes that range from 3 to 7 percent.

Erosion by water is the main hazard where these soils are cultivated. Soil blowing also is a hazard where they are not adequately protected. Some plant nutrients, mainly phosphorus, are not available where the soils are calcareous at the surface. The soils are low in nitrogen in cultivated areas. Dryfarmed crops can be affected by drought because much of the rainfall is lost as runoff, which is medium to rapid. Where crops are irrigated, efficent water management and erosion control are needed.

The soils of this mapping unit are dryfarmed. Corn, alfalfa, wheat, and grain sorghum are the main crops. A high level of management is needed for sustained production. Some areas are in native grass. Because of the hazards, more acreage needs to be returned to grass and used for pasture. Trees are grown successfully in windbreaks. These soils also provide food and cover for wildlife. (Capability units IVe-9 dryland and IVe-12 irrigated; Coly part in Limy Upland range site, and Kenesaw part in Silty range site; Silty to Clayey windbreak suitability group)

Cozad Series

This series consists of deep, nearly level, well-drained soils on stream terraces in the Platte River valley. These soils formed in medium-textured material that was washed from upland areas.

In a representative profile, the surface layer is grayish-brown silt loam about 7 inches thick. The brown subsoil, about 14 inches thick, is slightly calcareous silt loam. The underlying material is very pale brown, calcareous silt loam to a depth of 33 inches. Next below is a buried soil horizon of dark-gray, calcareous silt loam that is 9 inches thick. Beneath this, to a depth of 60 inches, is very pale brown, calcareous silt loam that has few, fine, faint mottles.

Cozad soils have moderate permeability and high available water capacity. They are moderate in organic-matter content and high in natural fertility. The surface layer is neutral, and the lower horizons are mildly to moderately alkaline.

Cozad soils are used principally for cultivated crops. A large acreage is irrigated. These soils are also suited to growing grass for pasture or trees for windbreaks. They provide habitat for wildlife.

Representative profile of Cozad silt loam, 300 feet north and 100 feet east of the southwest corner of sec. 9, T. 8 N., R. 20 W., in a cultivated field:

Ap--0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B--7 to 21 inches, brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, subangular blocky structure parting to massive; soft, very friable; slight effervescence; mildly alkaline; few small and medium lime concretions; clear, smooth boundary.

C--21 to 33 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; soft, very friable; violent effervescence; moderately alkaline; many small and medium lime concretions; abrupt, smooth boundary.

Ab--33 to 42 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, subangular blocky structure; soft, friable; strong effervescence; moderately alkaline; many prominent white lime streaks; clear, smooth boundary.

Cb--42 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; few, fine, faint mottles; massive; soft, very friable; strong effervescence; moderately alkaline.

The A horizon, which ranges from 7 to 11 inches in thickness, is mostly silt loam and very fine sandy loam. The B horizon is 10 to 16 inches thick and is silt loam or very fine sandy loam. A buried soil layer is common between depths of 24 and 42 inches. Depth to lime ranges from 7 to 24 inches. Where the soil is near bottom lands, mixed sand and gravel is at depths of as little as 5 feet. In the representative profile, lime is nearer the surface than is normal for the series.

Cozad soils are associated with those of the Hord, Hobbs, and Grigston series. They are not so dark as Hord soils and have lime closer to the surface. Cozad soils have a thinner, browner A horizon than Hobbs soils. They are not so dark as Grigston soils, have less clay in the C horizon, and are higher in elevation.

Cozad silt loam (0 to 1 percent slopes) (Coz).--This soil is in large continuous areas on stream terraces in the Platte River valley. Included in mapping were small areas of Grigston silt loam and Leshara silt loam.

This soil is easy to till. It absorbs water readily and responds well to irrigation. Surface runoff is slow. Dryfarmed crops can be damaged by drought. Where this soil is irrigated, maintaining fertility and efficiently using water are the main concerns in management.

Nearly all the acreage is cultivated, and a large part is irrigated. Alfalfa, corn, and grain sorghum are the principal crops. Trees are grown successfully in windbreaks. This soil also provides habitat for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty Lowland range site; Silty to Clayey windbreak suitability group)

Crete Series

This series consists of deep, nearly level, moderately well drained soils on uplands. These soils formed in loess, a wind-deposited silty material.

In a representative profile, the surface layer is dark-gray silt loam 16 inches thick. The subsoil, has a total thickness of 16 inches. The upper part is 3 inches of very dark grayish brown, firm silty clay loam; the middle part is 9 inches of dark grayish brown, very firm silty clay; and the lower part is 4 inches of brown, firm silty clay. The underlying material reaches to a depth of 60 inches. It is pale-brown light silty clay loam in its upper part and grades downward to pale-brown silt loam. This material is calcareous below a depth of 42 inches.

Crete soils have slow permeability, moderate organic-matter content, and high natural fertility. Although these soils have a high available water capacity, they are droughty when dryfarmed. The subsoil is very hard when dry. The surface layer and subsoil are slightly acid to neutral, and the underlying material is mildly alkaline.

Nearly all the acreage is cultivated, and a large part is irrigated. Crete soils also are suited to use as range and pasture. Trees are grown successfully. These soils provide food and cover for wildlife.

Representative profile of Crete silt loam, 100 feet north and 0.2 mile east of the southwest corner of sec. 36, T. 5 N., R. 18 W., in a cultivated field:

Ap--0 to 6 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A1--6 to 16 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, medium to coarse, subangular blocky structure; slightly hard, friable; neutral; clear, smooth boundary.

B1t--16 to 19 inches, very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, subangular blocky structure; hard, firm; neutral; clear, smooth boundary.

B21t--19 to 28 inches, dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic structure parting to strong, medium, angular blocky structure; shiny surfaces on peds; continuous clay films; very hard, very firm; neutral; clear, smooth boundary.

B22t--28 to 32 inches, brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; shiny surface on peds; hard, firm; neutral; gradual, smooth boundary.

C1--32 to 42 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; mildly alkaline; gradual, smooth boundary.

C2--42 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; few faint reddish-brown stains; weak, coarse, prismatic structure parting to massive; slightly hard, very friable; strong effervescence; mildly alkaline.

The A horizon ranges from 12 to 20 inches thick and is medium acid to neutral. The B horizon is 14 to 24 inches thick. Depth to lime ranges from 40 inches to more than 60 inches. Lime concretions are in the C horizon of many Crete soils.

Crete soils are associated with Holdrege, Detroit, and Butler soils. They have a finer textured B horizon than Holdrege or Detroit soils and are not so dark as Detroit soils. They lack the light-gray A2 horizon of Butler soils.

Crete silt loam (0 to 1 percent slopes) (Ce).--This soil is in small areas on the loess uplands. Included in mapping were small areas of Holdrege, Detroit, and Butler soils.

Surface runoff is slow. When saturated, the surface layer is difficult to work because the tight subsoil does not permit soil moisture to move downward rapidly enough. This soil responds well to irrigation. In places where the subsoil has been exposed by land leveling operations, tillage is difficult. Many areas of Crete soils are too small to manage separately.

Nearly all the acreage of this soil is cultivated. Wheat, corn, alfalfa, and grain sorghum are the main crops. A small acreage remains in native grasses. Trees are grown successfully in windbreaks. The soil also provides habitat for wildlife. (Capability units IIs-2 dryland and IIs-2 irrigated; Clayey range site; Silty to Clayey windbreak suitability group)

Detroit Series

This series consists of deep, nearly level, moderately well drained soils on uplands. These soils formed in loess, a silty wind-deposited material.

In a representative profile, the surface layer is gray and very dark gray silt loam about 12 inches thick. The subsoil is 36 inches thick. The upper 4 inches is dark-gray, firm silty clay loam. The next 16 inches is dark grayish brown, heavy silty clay loam, and below it is a 6-inch layer of grayish-brown, firm silty clay loam. The bottom 10 inches of the subsoil is light brownish gray silt loam in

which lime accumulated. The underlying material, from a depth of 48 to 60 inches, is light-gray silt loam.

Detroit soils have slow permeability and a high available water capacity. The organic-matter content is moderate, and natural fertility is high. The surface layer and upper part of the subsoil are neutral, the middle part of the subsoil is mildly alkaline, and the lower subsoil and underlying material are moderately alkaline. Most of the acreage of Detroit soils is cultivated. These soils respond well to irrigation. They also are suited to growing grasses for pasture and trees in windbreaks. They provide food and cover for wildlife.

Representative profile of Detroit silt loam, 100 feet north and 2,565 feet west of the southeast corner of sec. 36, T. 5 N., R. 18 W., in a cultivated field:

Ap--0 to 5 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

A1--5 to 12 inches, very dark gray (10YR 3/1) silt loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure parting to weak, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B1t--12 to 16 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, firm; neutral; clear, smooth boundary.

B21t--16 to 32 inches, dark grayish brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure parting to moderate, medium and fine, blocky structure; hard, firm; mildly alkaline; gradual, smooth boundary.

B22t--32 to 38 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure parting to moderate, medium, blocky structure; hard, firm; moderately alkaline; abrupt, smooth boundary.

B3ca--38 to 48 inches, light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; gradual, smooth boundary.

C--48 to 60 inches, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; weak, coarse, prismatic structure parting to massive; soft, very friable; strong effervescence; moderately alkaline.

The A horizon ranges from 10 to 19 inches in thickness and is slightly acid or neutral. The B2 horizon is heavy silty clay loam or light silty clay. Depth to lime ranges from 30 to 50 inches. The C horizon in some areas has faint, brownish mottles.

Detroit soils are associated with Holdrege, Crete, and Butler soils. They have more clay in the B horizon than Holdrege soils but are not so clayey as Crete or Butler soils. They also lack the gray A2 horizon of the Butler soils.

Detroit silt loam (0 to 1 percent slopes) (De).--This soil is on flats in the loess uplands. The areas are generally small. Included in mapping were small areas of nearly level Holdrege and Butler soils.

Surface runoff is slow. When dryfarmed, crop production in some years is limited by inadequate rainfall. This soil responds well to irrigation. It is subject to blowing when not protected by crop residue or a growing crop.

Nearly all the acreage is cultivated. Corn, wheat, grain sorghum, and alfalfa are the principal crops. Grasses and trees are grown successfully. The soil provides food and cover for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Grigston Series

This series consists of deep, well-drained soils on bottom lands in the Platte River valley. These soils formed in medium textured and moderately fine textured alluvium that is 3 to 6 feet thick and is underlain by sand and gravel.

In a representative profile, the surface layer is dark gray and very dark gray silt loam about 15 inches thick. Beneath it is a 4-inch transition layer of gray very fine sandy loam. The underlying material, which extends to a depth below 60 inches, is grayish-brown light silty clay loam in the upper part, brown silt loam in the middle part, and light-gray silt loam in the lower part. The underlying material is calcareous.

Grigston soils have moderate permeability and high available water capacity. They have moderate organic-matter content and high natural fertility. The surface layer is neutral, and the underlying material is mildly to moderately alkaline.

Soils of the Grigston series are used mainly for production of cultivated crops. Some acreage is still in native range. Trees are grown successfully in windbreaks, which provide food and cover for wildlife.

Representative profile of Grigston silt loam, 250 feet north and 100 feet west of the southeast corner of sec. 16, T. 8 N., R. 19 W., in a cultivated field:

Ap--0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A1--7 to 15 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure; slightly

hard, friable; neutral; clear, smooth boundary.

AC--15 to 19 inches, gray (10YR 5/1) very fine sandy loam, very dark brown (10YR 2/2) when moist; weak, coarse, blocky structure parting to massive; slightly hard, very friable; neutral; many pebbles; gradual, smooth boundary.

C1--19 to 32 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, subangular blocky structure; hard, friable; slight effervescence; mildly alkaline; gradual, wavy boundary.

C2--32 to 40 inches, brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, subangular blocky structure; hard, very friable; violent effervescence; few soft lime concentrations; moderately alkaline; clear, smooth boundary.

C3--40 to 60 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; massive; slightly hard, friable; violent effervescence; few prominent lime concentrations; moderately alkaline.

The A horizon ranges from 8 to 19 inches in thickness. It has a weak granular or crumb structure. There are faint mottles below a depth of 40 inches in some places. Depth to lime ranges from 15 to 48 inches. The C horizon commonly is stratified with lenses and layers of moderately fine textured to moderately coarse textured material. The water table is 4 to 12 feet from the surface.

Grigston soils are associated with Leshara and Wann soils. They are similar to Leshara soils in texture but have a finer textured C horizon than Wann soils. The water table is lower in Grigston soils than in Wann and Leshara soils.

Grigston silt loam (0 to 1 percent slopes) (Gp). This soil forms large continuous areas at the highest elevations on bottom lands along the Platte River. Included in mapping were small areas of Wann and Leshara soils that are at slightly lower elevations.

This is a good soil for cultivation. When dryfarmed, it can be somewhat droughty during the hot summer months. When irrigated, fertility maintenance and water management need careful attention. The surface layer is subject to soil blowing if not adequately protected.

Practically all of this soil is cultivated. Most is irrigated, but some is dryfarmed. Grass and trees grow well on this soil, and it provides food and cover for wildlife. (Capability units I-1 dryland and I-1 irrigated; Silty Lowland range site; Silty to Clayey windbreak suitability group)

Hobbs Series

This series consists of deep, nearly level to very gently sloping, well-drained soils that formed in medium-textured alluvial material. These soils are on narrow bottoms in upland canyons, at the uppermost ends of drainage systems that head in the loess uplands.

In a representative profile, the surface layer is gray silt loam about 30 inches thick. Below it is a transitional layer of light brownish gray friable silt loam about 10 inches thick. The underlying material extends to a depth of 60 inches and is pale-brown silt loam.

Hobbs soils have moderate permeability and high available water capacity. They are moderate in organic-matter content and high in natural fertility.

Most of the acreage of Hobbs soils is in native range, because the areas generally are too narrow for easy and efficient use of machinery. Some areas are cultivated. These are the areas sufficiently wide and least exposed to flooding. Hobbs soils are suited to grasses and trees and also provide food and cover for wildlife.

Representative profile of Hobbs silt loam, 400 feet north and 0.1 mile west of the southeast corner of sec. 32, T. 5 N., R. 18 W., in native range:

A11--0 to 4 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12--4 to 20 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure; slightly hard, friable; neutral; gradual, smooth boundary.

A13--20 to 30 inches, gray (10YR 5/1) heavy silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; neutral; gradual, smooth boundary.

AC--30 to 40 inches, light brownish gray (10YR 6/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic parting to weak, medium, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

C--40 to 60 inches, pale-brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) when moist; massive; soft, very friable; slight effervescence; moderately alkaline.

The A horizon ranges from 20 to 40 inches in thickness and from gray or grayish brown to dark grayish brown in color. Depth to lime is more than 40 inches, except where the surface layer is calcareous because calcareous material has washed onto it from adjacent uplands. The AC and C horizons are commonly stratified with light and dark material that ranges from silt loam to light silty clay loam. Some profiles have silty clay below a depth of 40 inches.

Hobbs soils are associated with Coly and Holdrege soils. They have a thicker and darker A horizon than Coly soils and a thicker A horizon than Holdrege soils Hobbs soils also lack the well defined B horizon of Holdrege soils.

Hobbs silt loam (0 to 2 percent slopes) (Hb).--This nearly level soil is on long narrow bottom lands in entrenched drains and canyons in the loess uplands. It receives water from higher lying soils. This soil has the profile described as representative of the series.

Surface runoff is slow to medium. A natural drain facilitates water removal from most areas of this soil. Flooding and water erosion are the main hazards.

Most of the acreage is in native range. Only a small acreage is cultivated because machinery cannot be used efficiently in such long and narrow areas. About one crop in four is lost to flooding. Grain sorghum and corn are the principal crops. Trees are grown successfully in windbreaks. This soil provides good habitat for wildlife. (Capability units IIw-31 dryland and IIw-3 irrigated; Silty Overflow range site; Moderately Wet windbreak suitability group)

Hobbs silt loam, overwash (0 to 1 percent slopes) (2Hb).--This nearly level soil is on uplands at the heads of drains and around shallow depressions. Its profile is similar to the one described as representative of the series, but the surface layer is not so dark and a moderately fine textured to fine textured layer is at a depth of 36 to 60 inches. Included in mapping were small areas of Butler silt loam, depressional.

This is a good soil for cultivation. During dry years, crops can be damaged by drought. Because this soil is generally at a lower elevation than surrounding areas, it is flooded occasionally. It is suited to irrigation if protected from flooding.

Most of the acreage is cultivated. Corn, wheat, and grain sorghum are the most common crops. Trees are grown successfully in windbreaks. This soil provides food and cover for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty Lowland range site; Silty to Clayey windbreak suitability group)

Holdrege Series

This series consists of deep, nearly level to moderately sloping, well-drained soils that formed in loess. These soils are on flats and on sides of intermittent drains in the uplands.

In a representative profile, the surface layer is silt loam about 13 inches thick. The upper part is gray, and the lower part is dark gray. The subsoil, which is about 26 inches thick, is friable, grayish-brown heavy silt loam in the upper part, grayish-brown to light brownish gray, firm silty clay loam in the middle part, and pale-brown friable silt loam in the lower part. The underlying material, below a depth of 39 inches, is light-gray silt loam.

Holdrege soils have moderate permeability and high available water capacity. They have moderate organic-matter content and high natural fertility. The surface layer is slightly acid or neutral, the subsoil is neutral or mildly alkaline, and the underlying material is moderately alkaline.

Holdrege soils are used mainly for cultivated crops. Some of the moderately sloping areas are in native grasses. Holdrege soils are suited to growing trees for windbreaks. They also provide food and cover for wildlife.

Representative profile of Holdrege silt loam, 0 to 1 percent slopes, 0.3 mile south and 100 feet west of the northeast corner of sec. 34, T. 5 N., R. 19 W., in a cultivated field:

Ap--0 to 6 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

A1--6 to 13 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure; slightly hard, very friable; neutral; clear, smooth boundary.

B1--13 to 16 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, medium and fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B21t--16 to 26 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm; mildly alkaline; clear, smooth boundary.

B22t--26 to 30 inches, light brownish-gray (10YR 6/2) light silty clay loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure parting to weak, medium and fine, subangular blocky structure; hard, firm; mildly alkaline; clear, smooth boundary.

B3--30 to 39 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky structure; slightly hard, friable; mildly alkaline; gradual, smooth boundary.

C--39 to 60 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; weak, coarse, prismatic structure parting to massive; soft, very friable; strong effervescence; many, fine, soft lime streaks and lime accumulations; moderately alkaline.

The A horizon ranges from 10 to 19 inches in thickness. The B horizon, which ranges from 12 to 26 inches in thickness, is heavy silt loam or light silty clay loam. A layer where lime accumulated is common. The depth to free lime ranges from 24 to 40 inches. In mapping unit HwB3 the surface layer is thinner and lighter colored than the defined range for the series but this does not alter the use or behavior of the soil.

Holdrege soils are associated with Coly, Detroit, Crete, and Butler soils. They have a thicker and darker A horizon than Coly soils and a less clayey B horizon than Detroit, Crete, or Butler soils. Holdrege soils have a B horizon, which is lacking in Coly soils.

Holdrege silt loam, 0 to 1 percent slopes (Ho).--This soil is nearly level and is more extensive than any other soil in Phelps County. Most areas are irregular in shape and range from 20 to 320 acres in size. The profile of this soil is the one described as representative of the series (pl. II, left). Included in mapping were small areas of Butler silt loam, depressional, and Detroit silt loam. Some of the smaller depressions are indicated on the map by a spot symbol.

This soil is easily worked and takes in water readily. Crops grown on it can be damaged by lack of moisture during years of below-normal rainfall. Soil blowing is a hazard where the surface is not adequately protected by a growing crop or by crop residue. Maintaining fertility and efficient water management are the main concerns where crops are irrigated. This soil is well suited to cultivation and responds well to irrigation. Corn, alfalfa, sorghum, and wheat are the principal crops. Grasses and trees are grown successfully. The soil provides food and cover for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege silt loam, 1 to 3 percent slopes (HoA).--This soil is very gently sloping. Its profile is similar to the one described as representative of the series except that the surface layer and subsoil are slightly thinner. Included in mapping were small areas of eroded Holdrege soils and nearly level Holdrege soils.

Water erosion, soil blowing, and a lack of adequate moisture are hazards where this soil is cultivated. Maintaining fertility and efficiently managing water are the main concerns where crops are irrigated. This soil is well suited to cultivation and responds well to irrigation. Wheat, corn, alfalfa, and grain sorghum are the principal crops. Grasses and trees are grown successfully. The soil provides food and cover for wildlife. (Capability units IIe-1 dryland and IIe-1 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege silt loam, 1 to 3 percent slopes, eroded (HoA2).--This soil is on divides and low ridges between areas of steeper soils. Its profile is similar to the one described as representative of the Holdrege series except that the surface layer and subsoil are thinner.

In some places, the surface layer is light silty clay loam. In other places, the surface layer has become mixed with the upper part of the subsoil by tillage, and as a result is grayish brown or brown and cloddy and hard when dry. Included in mapping were small areas of uneroded Holdrege silt loam and nearly level Holdrege silt loam.

Water erosion and soil blowing are hazards where this soil is cultivated. Maintaining fertility and efficient management of water are the main concerns where crops are irrigated.

Almost all the acreage is cultivated. Corn, wheat, alfalfa, and grain sorghum are the principal crops. This soil responds well to irrigation. It is suited to grass for pasture and to trees in windbreaks. It also provides habitat for wildlife. (Capability units IIe-1 dryland and IIe-1 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege silt loam, 3 to 7 percent slopes (HoB).--This soil is on the sides of drains in the loess uplands, and in places it is on ridges between areas of steeper soils. Its profile is similar to the one described as representative of the series except that the subsoil is thinner. Included in mapping were small areas of nearly level and very gently sloping Holdrege soils.

Water erosion is a hazard where this soil is cultivated. Soil blowing can be a hazard if the soil is not adequately protected by a growing crop or by crop residue.

Most of the acreage of this soil is in native grasses. Some is dryfarmed. Corn, alfalfa, grain sorghum, and wheat are the principal crops. The soil is suited to irrigation. Trees are successfully grown in windbreaks. The soil provides cover and food for wildlife. (Capability units IIIe-1 dryland and IIIe-1 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege silt loam, 3 to 7 percent slopes, eroded (HoB2).--This soil is on the sides of drains and on some divides between steeper soils. Its profile is similar to the one described as representative of the series except that the surface layer and subsoil are thinner and the depth to lime is less. In places, the surface layer is only as thick as the plowed surface because erosion has removed much of the original dark soil. Where erosion has been severe, the surface layer is light silty clay loam. Included in mapping were small areas of very gently sloping Holdrege silt loam.

Water erosion and soil blowing are hazards where this soil is cultivated. Maintaining fertility is a concern because the eroded areas are low in organic-matter content and plant nutrients.

Most of the acreage is dryfarmed. Corn, alfalfa, grain sorghum, and wheat are the main crops. The soil is suited to irrigation, but efficient application of water, erosion control, and maintenance of fertility are necessary parts of good management. Trees can be grown successfully in windbreaks. The soil provides food and cover for wildlife. (Capability units IIIe-1 dryland and IIIe-1 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege silt loam, 7 to 10 percent slopes (HoC).--This moderately sloping soil is on sides of drains and on ridges between canyons. Its profile is similar to that described as representative of the series except that the surface layer and subsoil are thinner. Depth to lime averages about 22 inches. Included in mapping were small areas of Coly silt loam, 10 to 30 percent slopes, and Holdrege silt loam, 3 to 7 percent slopes.

Surface runoff is rapid. Where this soil is cultivated, it is especially susceptible to erosion by water. Soil blowing is an additional hazard in cultivated areas, and maintaining fertility is a concern. This soil can be irrigated, but the hazards and limitations are severe.

Most of the acreage is in native grasses, but some areas are cultivated. The main crop is wheat; other crops are sorghum, corn, and alfalfa. Trees are grown successfully in windbreaks. The soil also provides cover and food for wildlife. (Capability units IVe-1 dryland and IVe-1 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege soils, 3 to 7 percent slopes, severely eroded (HwB3).--This soil is on the sides of drains and on ridgetops between steeper soils. Its profile is similar to the one described as representative of the series except that the surface layer is thinner and lighter colored. Erosion has removed most of the original dark material from the surface layer. In some places where the soil is cultivated, the remaining surface layer has become mixed with the upper part of the subsoil. Thus the surface layer is silt loam in some places and silty clay loam in other places. Included in mapping were small areas of Holdrege silt loam, 1 to 3 percent slopes, eroded, and Holdrege silt loam, 3 to 7 percent slopes, eroded.

Erosion by water, soil blowing, and low fertility are the main hazards associated with cultivating this soil. Small gullies are common and are plowed in with each tillage operation. This soil has very low organic-matter content. Lack of sufficient moisture is common in many years, because much of the rainfall is lost to surface runoff. This soil can be irrigated, but the erosion hazard is severe. Maintaining fertility and efficient water management are other concerns where the soil is irrigated. Selection of a suitable system of irrigation is important.

Nearly all the acreage is cultivated. Some areas are seeded to grasses and used as pasture. Alfalfa, wheat, corn, and grain sorghum are the principal crops. Trees can be grown successfully in windbreaks. The soil provides food and cover for wildlife. (Capability units IVe-8 dryland and IVe-11 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Holdrege-Coly complex, 7 to 10 percent slopes, eroded (HCC2).--This mapping unit is on sides of drains and is composed of 65 percent Holdrege silt loam and 35 percent Coly silt loam. The profiles of the Holdrege and Coly soils are lighter but are otherwise similar to those described as representative for their respective series.

Included in mapping were a few areas of Holdrege silt loam, 1 to 3 percent slopes, eroded, and Holdrege silt loam, 3 to 7 percent slopes, eroded.

Surface runoff is rapid. Dryfarmed crops can be damaged by lack of adequate moisture. Water erosion, soil blowing, and low fertility are the main hazards where this mapping unit is cultivated. Gullies are common and are a hazard if large machinery is used. This soil can be irrigated, but the limitations and hazards are great. Maintaining fertility, erosion by water, and selection of the correct method of distributing water are the main concerns where crops are irrigated.

Most of the acreage is cultivated. Alfalfa is the crop best suited to this soil, but wheat, corn, and sorghum are also grown. Trees are grown successfully in windbreaks. These soils also provide food and cover for wildlife. (Capability units IVe-8 dryland and IVe-11 irrigated; Holdrege part in Silty range site and Coly part in Limy Upland range site; Silty to Clayey windbreak suitability group)

Hord Series

This series consists of deep, nearly level, well-drained, medium-textured soils on stream terraces in the valley of the Platte River, along Spring Creek, and in the loess uplands.

In a representative profile, the surface layer is dark-gray silt loam about 19 inches thick. The subsoil, also 19 inches thick, is friable heavy silt loam that is dark grayish brown in the upper part and light brownish gray in the lower part. The underlying material, between depths of 38 and 60 inches, is light-gray calcareous silt loam.

Hord soils have moderate permeability and high available water capacity. They have moderate organic-matter content and high natural fertility. The surface layer is neutral, the subsoil is neutral or slightly alkaline, and the underlying material is moderately alkaline.

Hord soils are used mainly for cultivated crops. They are well suited to irrigation. These soils can be used for growing grasses and trees, which provide food and cover for wildlife.

Representative profile of Hord silt loam, terrace, 0.4 mile east and 100 feet north of the southwest corner of sec. 23, T. 8 N., R. 19 W., in a cultivated field:

Ap--0 to 6 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A1--6 to 19 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure parting to weak, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B2--19 to 26 inches, dark grayish brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; neutral; clear, smooth boundary.

B3--26 to 38 inches, light brownish gray (2.5Y 6/2) heavy silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky

structure; slightly hard, friable; slightly alkaline; gradual, smooth boundary.

C--38 to 60 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; massive; slightly hard, very friable; violent effervescence; moderately alkaline; many small lime concretions.

The A horizon ranges from 12 to 30 inches in thickness, and the B horizon from 7 to 20 inches. The B2 horizon, which is commonly as dark as the A horizon, is mostly silt loam where the soil is on stream terraces and light silty clay loam where it is on loess uplands. Depth to lime ranges from 30 to 50 inches.

Hord soils are associated with Cozad, Holdrege, Detroit, and Kenesaw soils. They have a thicker A horizon than Cozad soils. The B horizon is less clayey than that of either the Holdrege or Detroit soils. Hord soils are darker and have a B horizon, which is not present in Kenesaw soils.

Hord silt loam (0 to 1 percent slopes) (Hd).--This is a nearly level soil on the loess uplands. It lies slightly above the level of shallow depressions. Its profile is similar to the one described as representative of the series, but its surface layer is thicker and its subsoil is slightly more clayey. Included in mapping were a few small areas of Holdrege silt loam, 0 to 1 percent slopes.

Surface runoff is slow. A lack of adequate rainfall is the main limitation to growing crops where this soil is dryfarmed. If this soil is not protected, it is susceptible to soil blowing. Where crops are irrigated; maintaining fertility is a concern.

Nearly the entire acreage is cultivated, and most is irrigated. Corn, wheat, alfalfa, sorghum, soybeans, and sugar beets are suited to this soil. Trees are grown successfully in shelterbelts. This soil provides habitat for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Hord silt loam, terrace (0 to 1 percent slopes) (2Hd).--This soil is on stream terraces in the Platte River valley and along Spring Creek. Its profile is the one described as representative of the series. Included in mapping were a few small areas of Cozad silt loam.

Surface runoff is slow. This soil is excellent for dryfarmed or irrigated crops. During some years, however, rainfall is not adequate for dryfarmed crops. Fertility maintenance is a concern, particularly where the soil is irrigated.

This soil is well suited to cultivation. The main crops are corn, wheat, grain sorghum, and alfalfa. Grasses and trees are grown successfully. Areas of this soil provide food and cover for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty Lowland range site; Silty to Clayey windbreak suitability group)

Kenesaw Series

This series consists of deep, nearly level to gently sloping, well-drained, medium-textured soils on loess uplands and stream terraces.

In a representative profile, the surface layer is grayish-brown to dark-gray silt loam, about 7 inches thick. Beneath it is a transition zone of pale-brown silt loam that is 13 inches thick. The upper 16 inches of the underlying material is light brownish gray calcareous silt loam that has many reddish-brown iron stains; the lower part, to a depth of 60 inches, is light-gray calcareous silt loam that lacks the iron stains.

Kenesaw soils have moderate permeability and high available water capacity. They have moderate organic-matter content and medium natural fertility.

Most of the acreage is dryfarmed, but some is in native range. Trees are grown successfully in windbreaks. These soils provide food and cover for wildlife.

Representative profile of Kenesaw silt loam, 0 to 1 percent slopes, 0.1 mile east and 150 feet north of the southwest corner of sec. 13, T. 7 N., R. 18 W., in a cultivated field:

Ap--0 to 5 inches, grayish-brown (10YR 5/2) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

A1--5 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure parting to moderate, fine, granular structure; slightly hard, very friable; neutral, abrupt, smooth boundary.

AC--7 to 20 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to weak, very fine, subangular blocky structure; slightly hard, very friable; neutral, gradual, wavy boundary.

C1--20 to 36 inches, light brownish gray (10YR 7/2) silt loam; grayish brown (10YR 5/2) when moist; many medium, distinct, reddish-brown iron stains; massive; soft, very friable; violent effervescence; mildly alkaline; small, pipelike concretions; few snail shells and large worm casts; root channels filled with lime; abrupt, smooth boundary.

C2--36 to 60 inches, light-gray (10YR 7/2) silt loam; light brownish gray (2.5Y 6/2) when moist; massive; soft, very friable; violent effervescence; moderately alkaline; few snail shells and large worm casts; root channels filled with lime.

The A horizon ranges from 7 to 18 inches in thickness and has a weak crumb structure to medium granular structure. The AC horizon is 6 to 16 inches thick and ranges from loam to silt loam in texture. The C horizon is stratified in places with medium textured to moderately coarse textured soil material. Depth to lime ranges from 12 to 36 inches. In places, buried soils are common.

Kenesaw soils are associated with Anselmo, Coly, and Holdrege soils. They are not so coarse textured as Anselmo soils. They have a thicker A horizon than Coly soils but a thinner A horizon than Holdrege soils. Kenesaw and Coly soils differ from Anselmo and Holdrege soils in that they lack a B horizon.

Kenesaw silt loam, 0 to 1 percent slopes (Ks).--This nearly level soil is formed in loess on uplands. Its profile is the one described as representative of the series (pl. II, middle). The surface layer in a few areas adjacent to Anselmo or Valentine soils is fine sandy loam or loamy sand. Included in mapping were small areas of Kenesaw and Coly silt loams, 1 to 3 percent slopes.

A lack of adequate moisture during the growing season is the main hazard where this soil is cultivated. Soil blowing can be a hazard if the soil is not protected by a growing crop or by crop residue. Maintaining fertility is a concern, particularly where crops are irrigated. Application of excessive amounts of water can leach the applied fertilizer beneath the rooting zone of most crops. Some leveling of this soil is generally needed for efficient management of irrigation water.

Most of the acreage is cultivated, and about half is irrigated. Corn, wheat, alfalfa, and grain sorghum are the main crops. Only a small acreage is in native range. Trees are grown successfully in windbreaks. The soil provides habitat for wildlife. (Capability units IIc-1 dryland and I-2 irrigated; Silty range site; Silty to Clayey windbreak suitability group)

Kenesaw silt loam, terrace, 1 to 3 percent slopes (2KsA).--This soil is on stream terraces in the Platte River valley and in small areas along Spring Creek. Its profile is similar to the one described as representative of the series except that the surface layer is slightly thicker. Lime is leached to an average depth of 30 inches. Included in mapping were small areas of Hord silt loam.

Soil blowing and erosion by water are the main hazards where this soil is cultivated. Maintaining fertility and efficient water management are concerns where the soil is irrigated.

Nearly all of the acreage is cultivated, and much is irrigated. Corn, sorghum, wheat, and alfalfa are the main crops. A small acreage is still in native range. This soil is well suited to pasture and range grasses. Trees are grown successfully in windbreaks. The soil provides habitat for wildlife. (Capability units IIe-1 dryland and IIe-1 irrigated; Silty Lowland range site; Silty to Clayey windbreak suitability group)

Kenesaw and Coly silt loams, 1 to 3 percent slopes (KCA).--This mapping unit is on a low hummocky upland landscape. Kenesaw silt loam, which constitutes 60 percent of this mapping unit, is at the lowest elevations; the Coly silt loam, which constitutes the remaining 40 percent, is on the crests and sides of low hummocks (pl. I, bottom). Included in mapping were a few areas of Kenesaw silt loam, 0 to 1 percent slopes.

Erosion by water and soil blowing are hazards, and the need for improvement of fertility is the main concern where crops are cultivated. Soils in this mapping unit can be irrigated, although some grading and leveling generally is necessary for efficient water control. Where this is not possible, sprinkler irrigation can be used.

Most of the acreage is cultivated. Corn, grain sorghum, wheat, and alfalfa are the main crops. These soils are well suited to grasses for pasture. Trees are grown successfully in windbreaks. These soils provide habitat for wildlife. (Capability units IIIe-11 dryland and IIe-11 irrigated; Kenesaw part in Silty range site and Coly part in Limy Upland range site; Silty to Clayey windbreak suitability group)

Kenesaw and Coly silt loams, hummocky (3 to 7 percent slopes) (2KC).--This mapping unit is on an upland landscape where numerous small hummocks have gently sloping sides. The Kenesaw silt loam, which constitutes about 60 percent of the mapping unit, is in the lower part of the landscape. The Coly silt loam, which constitutes the remaining 40 percent, is on the hummocks. Included in mapping were small areas of Kenesaw and Coly silt loams, 1 to 3 percent slopes.

Where these soils are cultivated, erosion by water and soil blowing are the principal hazards. A lack of soil moisture limits the growth of dry-farmed crops. Maintaining fertility is a concern. Leveling this soil for irrigation is expensive, but sprinkler systems can be used for applying irrigation water without leveling the slopes.

Most of the acreage is in native range, a use to which these soils are well suited. Trees are grown successfully in windbreaks. The soils provide habitat for upland wildlife. (Capability units IIIe-1 dryland and IIIe-1 irrigated; Kenesaw part in Silty range site and Coly part in Limy Upland range site; Silty to Clayey windbreak suitability group)

Kenesaw and Coly silt loams, hummocky, eroded (3 to 7 percent slopes) (2KC2).--This mapping unit is on uplands where the landscape is hummocky. The sides of the hummocks are gently sloping. Kenesaw silt loam, which constitutes 50 percent of the mapping unit, is at the lower elevations and on the lower side slopes of the hummocks; the Coly silt loam, which constitutes the remaining 50 percent, is on the crests and upper side slopes of the hummocks. The profiles of these soils are similar to the ones described as representative of the series except that their surface layers are lighter colored and thinner. Lime is nearer to the surface in the Kenesaw soil and is at the surface in the Coly soil. Included in mapping were small areas of the Kenesaw silt loam, 0 to 1 percent slopes, small areas of Kenesaw and Coly silt loams, 1 to 3 percent slopes, and areas having moderately coarse surface layers.

These soils are susceptible to erosion by water and to soil blowing. They are lower in fertility than the same soils in areas that are less eroded. Maintaining fertility is a concern. Crops respond to fertilizer, but use of fertilizer needs to be balanced to the available moisture supply. Irrigation is practical if sprinklers are used or if the land is properly shaped.

Most of the acreage is cultivated. Corn, wheat, grain sorghum, and alfalfa are the main crops. These soils are suited to grass for pasture and range. Trees are grown successfully in windbreaks, which provide habitat for wildlife. (Capability units IIIe-1 dryland and IIIe-1 irrigated; Kenesaw part in Silty range site and Coly part in Limy Upland range site; Silty to Clayey windbreak suitability group)

Leshara Series

This series consists of deep, nearly level, somewhat poorly drained soils on bottom lands of the Platte River valley. Leshara soils formed in medium-textured material that was deposited by water. Depth to the water table ranges from 2 to 6 feet beneath the surface.

In a representative profile the surface layer is gray silt loam 12 inches thick. Below this is a transition layer of calcareous, grayish-brown silt loam that is 10 inches thick. Next below is a buried soil consisting of calcareous gray silt loam that is 8 inches thick. It is underlain by a transition layer of calcareous light brownish gray silt loam 6 inches thick, and below this is light-gray very fine to fine sandy loam that is 14 inches thick and is stained by yellowish-brown mottles. Pale-brown coarse sand and gravel occurs below a depth of 50 inches.

Leshara soils have moderate permeability, high available water capacity, moderate organic-matter content, and medium natural fertility. The surface layer is moderately alkaline, the transition layer and the upper layer of the buried soil are strongly alkaline, and the rest of the profile is moderately alkaline.

Leshara soils are used mainly for cultivated crops. A small acreage is in native range. Trees grow well in windbreaks. These soils provide food and cover for wildlife.

Representative profile of Leshara silt loam, 0.15 mile south and 150 feet west of the northeast corner of sec. 14, T. 8 N., R. 20 W., in a cultivated field:

Ap--0 to 6 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; slightly hard, very friable; moderately alkaline; abrupt, smooth boundary.

A1--6 to 12 inches, gray (10YR 5/1) heavy silt loam, very dark gray (10YR 3/1) when moist; weak, medium and coarse, blocky structure; slightly hard, friable; moderately alkaline; clear, smooth boundary.

AC--12 to 22 inches, grayish-brown (10YR 5/2) silt loam, dark gray (10YR 4/1) when moist; weak, coarse, blocky structure; slightly hard, very friable; strong effervescence; strongly alkaline; common fine salt accumulations; gradual, smooth boundary.

A1b--22 to 30 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, blocky structure parting to massive; slightly hard, very friable; violent effervescence; strongly alkaline; clear, smooth boundary.

ACb--30 to 36 inches, light brownish gray (10YR 6/2) silt loam, dark gray (10YR 4/1) when moist; weak, coarse, prismatic structure parting to massive; slightly hard, very friable; violent effervescence; moderately alkaline; gradual, smooth boundary.

C1b--36 to 42 inches, light-gray (10YR 6/1) light very fine sandy loam, brown (10YR 5/3) when moist; common, medium, faint, yellowish-brown (10YR 5/6) mottles; massive; soft, very friable; moderately alkaline; gradual, smooth boundary.

C2b--42 to 50 inches, light-gray (10YR 7/2) fine sandy loam, light brownish gray (10YR 6/2) when moist; common, medium, faint, yellowish-brown (10YR 5/6) mottles; massive; soft, very friable; moderately alkaline; abrupt, smooth boundary.

IIC--50 to 60 inches, very pale brown (10YR 7/3) coarse sand and gravel, pale brown (10YR 6/3) when moist; single grained; loose; moderately alkaline.

The A horizon ranges from 7 to 16 inches in thickness. The C horizon averages a medium texture but is commonly stratified with soil material that ranges from silty clay loam to fine sandy loam. Mottles can occur at any level in the C horizon. Silt loam, loam, and very fine sandy loam are the most common soil textures. Depth to the coarse sand and gravel ranges from 40 to more than 60 inches. Depth to lime ranges from 10 to 20 inches.

Leshara soils are associated with Wann, Platte, and Cass soils. They have a higher water table than Cass soils and are deeper than Platte soils. The upper part of the C horizon is finer textured than the material underlying Wann or Cass soils.

Leshara silt loam (0 to 1 percent slopes) (Le).--This soil is on bottom lands in the Platte River valley. Its profile is the one described as representative of the series. Included in mapping were small areas of Wann loam, Wann fine sandy loam, some areas that are calcareous at the surface, a few areas that are moderately saline, and a few areas where mixed sand and gravel are 20 to 40 inches below the surface.

Wetness early in spring can delay field preparation for crops. The abundance of lime in the underlying material causes a lack of available phosphorus for some crops. Maintaining fertility is a concern, particularly where the soil is irrigated.

Nearly all the acreage is cultivated, and most of it is irrigated. Corn, grain sorghum, and alfalfa are the main crops. Only a small acreage is still in native grass. Trees are grown successfully in windbreaks. This soil provides habitat for wildlife. (Capabilility units IIw-4 dryland and IIw-4 irrigated; Subirrigated range site; Moderately Wet windbreak suitability group)

Leshara silt loam, saline (0 to 1 percent slopes) (2Le).--This soil is on bottom lands in the Platte River valley. Its profile is similar to the one described as representative for the series except that it is moderately saline and alkaline. The soluble salts are mainly in the surface layer and upper part of the underlying material. This soil is lower in elevation than Leshara soils not affected by salinity, and the depth to the water table is about 1 foot less.

Nutrient deficiencies and wetness that can delay cultivation and planting are the main concerns where this soil is cultivated.

This soil responds well to irrigation. Corn, sorghum, and alfalfa are the main crops. Sugar beets, which are moderately tolerant of salinity, are grown in some places. Much of the acreage is still in native range. Trees that are tolerant of moderate concentrations of saline or alkali salts are grown successfully in windbreaks. This soil provides habitat for wildlife. (Capability units IVs-1 dryland and IIIs-1 irrigated; Saline Subirrigated range site; Moderately Saline alkali windbreak suitability group)

Loamy Alluvial Land

Loamy alluvial land (0 to 3 percent slopes) (Lx) is on bottom lands adjacent to the Platte River. It is nearly level to very gently sloping but is cut through by shallow abandoned river channels. The water table generally is at a depth of 6 to 18 inches but may rise to the surface or pond on the floor of the abandoned channels several times in some years. Included in mapping were small areas of Platte soils.

The surface layer is dark-gray loamy material, 1 to 8 inches thick, that is calcareous in most places. It is underlain by coarse sand or mixed sand and gravel.

Loamy alluvial land has very low available water capacity, low natural fertility, and low organic-matter content. The permeability of the underlying material is very rapid. Loamy alluvial land is unsuitable for cultivation and is used mainly for grazing. The vegetation is mostly native grasses and trees, but tall sedge and cattails grow in areas that are flooded frequently. Switchgrass and prairie cordgrass are the most common grasses, and cottonwood is the most common tree. Willows grow in some of the wetter areas. A few areas provide habitat for deer and quail. (Capability unit VIIs-3 dryland, not placed in irrigated capability unit; Subirrigated range site; Undesirable windbreak suitability group)

Marsh

Marsh (M) occurs in wet upland depressions and on bottom land in the Platte River valley. Water is near or above the surface during spring and early summer and following heavy rains. Some upland marsh is dry late in summer.

Marsh in upland depressions contains some medium textured to fine textured material. It is associated with Scott soils, and included in mapping were small areas of Scott silt loam, which has a profile similar to the one described as representative of the Scott series.

Marsh on bottom land has variable texture; it contains some sand and has mixed sand and gravel below depths of 4 to 5 feet. It is associated with Platte soils and Loamy alluvial land.

This mapping unit is very poorly drained. It has moderate to slow permeability, and surface runoff is lacking. It is too wet for cultivated crops and for most grasses and trees. Vegetation consists mostly of cattails, rushes, and tall sedges. Reedgrass, canarygrass, and willows grow on the periphery of marsh in some places. Some small areas lack vegetation.

Marsh is too wet for cultivated crops and for most grasses and trees. The native vegetation provides food and cover for wetland wildlife. (Capability unit VIIIw-1 dryland, not placed in irrigated capability unit; not placed in a range site; Undesirable windbreak suitability group)

Meadin Series

This series consists of shallow, nearly level to very gently sloping, excessively drained soils that are underlain by mixed sand and gravel from depths of 10 to 20 inches beneath the surface (pl. II, right). Meadin soils occur in broad, continuous areas on stream terraces in the Platte River valley.

In a representative profile, the surface layer is grayish-brown loamy sand about 6 inches thick. Beneath this is a 6-inch transition layer of brown loamy sand. Next below is coarse sand and gravel that is brown to a depth of 26 inches and light gray beneath that depth. The lower part is faintly mottled with yellowish-brown stains. The surface layer and transition layer have rapid permeability, and the layer of coarse sand and gravel has very rapid permeability. Meadin soils have very low available water capacity, low organic-matter content, and low natural fertility. The surface layer is slightly acid, and other parts of the profile are neutral.

Meadin soils are used mainly for grazing. They can be irrigated but the limitations are severe. Trees are grown successfully in shelterbelts. These soils provide habitat for wildlife.

Representative profile of Meadin loamy sand, terrace, 0 to 2 percent slopes, 0.4 mile south and

100 feet west of the northeast corner of sec. 26, T. 8 N., R. 17 W., in native range:

A1--0 to 6 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; loose; slightly acid; clear, smooth boundary.

AC--6 to 12 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to single grained; loose; neutral; clear, smooth boundary.

IIC1--12 to 26 inches, brown (10YR 5/3) coarse sand and gravel, dark brown (10YR 3/3) when moist; single grained; loose; neutral; gradual, smooth boundary.

IIC2--26 to 60 inches, light-gray (10YR 7/2) coarse sand and gravel, grayish brown (10YR 5/2) when moist; few, faint, coarse, yellowish-brown mottles in lower 4 inches; single grained; loose; neutral.

The A horizon ranges from 4 to 8 inches in thickness and is loamy sand or silt loam. Organic-matter content is low or very low.

Meadin soils are associated with O'Neill soils and with the terrace phases of Anselmo and Thurman soils. Meadin soils have a thinner A horizon and are shallower over sand and gravel than any of the associated soils.

Meadin loamy sand, terrace, 0 to 2 percent slopes (2Md).--This soil is on a stream terrace in the Platte River valley, and has a low hummocky topography. Its profile is the one described as representative of the series. Included in mapping were small areas of Valentine loamy sand and Thurman loamy fine sand, terrace, 0 to 3 percent slopes.

Surface runoff is slow. The coarse soil absorbs water about as rapidly as it falls. When a large amount of moisture is available, much of it is lost by movement through the underlying mixed sand and gravel. Roots of most plants do not penetrate the mixed sand and gravel. This soil has very low available water capacity and is droughty. It is susceptible to soil blowing where not adequately protected by vegetation.

This soil is used for grazing. It is not suited to cultivated crops. Eastern recedar can be grown in windbreaks, which wildlife use for cover and for sources of food. (Capability unit VIs-41 dryland, not placed in irrigated capability unit; Shallow to Gravel range site; Shallow windbreak suitability group)

Meadin silt loam, terrace, 0 to 1 percent slopes (2Mw).--This shallow soil is on low, broad, nearly level areas along drains that cross stream terraces in the Platte River valley. Its profile is similar to the one described as representative of the series except that the surface layer is silt loam. Included in mapping were a few small areas of Meadin loamy sand, terrace, 0 to 2 percent slopes.

This soil has very low available water capacity. It is droughty where cultivated. Roots do not grow in the very coarse underlying material. The soil can be irrigated, but runs need to be short and water must be applied frequently. Workability is good. Both the surface layer and the upper part of the underlying material are neutral.

Most of the acreage is still in native grasses. Where this soil is associated with deeper soils, few areas are cultivated and irrigated. Eastern redcedar can be grown successfully in windbreaks, which provide habitat for wildlife. (Capability units VIs-4 dryland and IVs-4 irrigated; Shallow to Gravel range site; Shallow windbreak suitability group)

O'Neill Series

This series consists of nearly level, well-drained soils that formed in water-deposited soil material on stream terraces in the Platte River valley. O'Neill soils are moderately deep over mixed sand and gravel.

In a representative profile, the surface layer is grayish-brown fine sandy loam about 10 inches thick. The subsoil is very friable, brown sandy loam about 14 inches thick. The underlying material, at a depth of 24 inches and continuing to below 60 inches, is a yellowish brown coarse sand in the upper part, light yellowish brown mixed sand and gravel in the middle part, and light-gray sand and gravel in the lower part.

O'Neill soils have moderately rapid permeability and low available water capacity. They have moderately low organic-matter content and medium natural fertility. When dryfarmed, they are droughty. The surface layer, subsoil, and upper and middle parts of the underlying material are neutral; the lower part of the underlying material is mildly alkaline.

O'Neill soils are used for grazing and cultivated crops. They respond well to irrigation and fertilizer. Trees are grown successfully in windbreaks. The soil areas provide food and cover for wildlife.

Representative profile of O'Neill fine sandy loam, 0 to 1 percent slopes, 150 feet north and 0.1 mile west of the southeast corner of sec. 22, T. 8 N., R. 17 W., in native range:

A11--0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft, very friable; neutral; clear, smooth boundary.

A12--5 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, medium, blocky structure; soft, very friable; neutral; clear, smooth boundary.

B--10 to 24 inches, brown (10YR 5/3) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky structure; soft, very friable; neutral; abrupt, smooth boundary.

IIC1--24 to 36 inches, yellowish-brown (10YR 5/4) coarse sand, dark yellowish brown (10YR 4/4) when moist; single grained; loose; neutral; gradual, smooth boundary.

IIC2--36 to 48 inches, light yellowish brown (10YR 6/4) coarse sand and gravel, brown (10YR 5/3) when moist; single grained; loose; neutral; abrupt, smooth boundary.
IIC3--48 to 60 inches, light-gray (10YR 7/2) coarse sand and gravel, light brownish gray (10YR 6/2) when moist; single grained; loose; mildly alkaline.

The A horizon ranges from 7 to 15 inches in thickness and from gray to grayish brown in color. It is slightly acid to neutral. Depth to coarse sand or sand and gravel ranges from 20 to 40 inches.

O'Neill soils are associated with Meadin soils and with the terrace phases of Anselmo and Thurman soils. O'Neill soils are deeper over the underlying sand and gravel than are the Meadin soils. They are not so deep as Anselmo or Thurman soils and are not so coarse textured as Thurman soils.

O'Neill fine sandy loam, 0 to 1 percent slopes (On).--This nearly level soil is on stream terraces in the Platte River valley. Included in mapping were small areas of Meadin loamy sand, terrace, 0 to 2 percent slopes, and Anselmo fine sandy loam, terrace, 0 to 3 percent slopes.

Surface runoff is slow. Soil blowing is a hazard where this soil is not protected by growing vegetation or organic cover. This soil has low available water capacity and is droughty where dryfarmed. Fertility maintenance is a concern in irrigated areas. The soil is easy to work.

Much of the acreage is still in native grasses. Some areas are cultivated and irrigated. Corn and grain sorghum are the main crops, and some alfalfa and wheat are grown. This soil is suited to windbreaks, which provide habitat for wildlife. (Capability units IIIe-3 dryland and IIIe-3 irrigated; Sandy range site; Sandy windbreak suitability group)

Platte Series

This series consists of shallow, nearly level to very gently sloping, somewhat poorly drained soils that formed in water-deposited soil material on bottom lands in the Platte River valley. These soils are shallow to mixed sand and gravel. The water table is 2 to 5 feet beneath the surface.

In a representative profile, the surface layer is heavy silty clay loam about 8 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The underlying material is light brownish gray, very friable sandy loam about 9 inches thick. Below a depth of 17 inches is light-gray mixed coarse sand and gravel. The soil is moderately alkaline throughout the profile.

Platte soils have moderately rapid permeability and low available water capacity. They have low organic-matter content and low natural fertility.

Most of the acreage is used for grazing. A small acreage is cultivated. These soils can be irrigated, but adapted crops are limited and surface drainage needs to be established for best results. Trees and shrubs can be grown successfully. Areas can be developed to provide food and cover for wildlife.

Representative profile of Platte silty clay loam in an area of Platte soils, 0.6 mile north and 50 feet west of the southeast corner of sec. 13, T. 8 N., R. 18 W., in native range:

A11--0 to 3 inches, very dark gray (10YR 3/1) heavy silty clay loam, black (10YR 2/1) when moist; weak, medium and fine, granular structure; very hard, firm; strong effervescence; moderately alkaline; clear, smooth boundary.
A12--3 to 8 inches, dark-gray (10YR 4/1) heavy silty clay loam, very dark gray (10YR 3/1) when moist; strong, medium, subangular blocky structure; very hard, firm; strong effervescence; moderately alkaline; abrupt, smooth boundary.
C--8 to 17 inches, light brownish gray (10YR 6/2) sandy loam, grayish brown (10YR 5/2) when moist; many prominent, coarse mottles; weak, coarse, subangular blocky structure parting to single grained; soft, very friable; moderately alkaline; abrupt, smooth boundary.
IIC--17 to 50 inches, light-gray (10YR 7/2) mixed coarse sand and gravel, grayish brown (10YR 5/2) when moist; single grained; loose; moderately alkaline.

The A horizon ranges from 7 to 12 inches in thickness. Its texture ranges from silty clay in the swales and old river channels to very fine sandy loam on slightly higher areas. These soils are moderately to strongly alkaline. Some areas are slightly to moderately saline or alkaline. The upper part of the C horizon is silt loam to fine sandy loam. Depth to mixed sand and gravel ranges from 10 to 20 inches.

Platte soils are associated with Wann and Leshara soils. Platte soils are shallower over mixed sand and gravel than Wann or Leshara soils. The depth to the water table in Platte soils is a little less than in these deeper soils.

Platte soils (0 to 1 percent slopes) (P).--This mapping unit occurs as long narrow areas near present channels of the Platte River. The surface layer ranges from silty clay to very fine sandy loam. The soil having the profile described as representative of the series is one of the soils that make up this mapping unit. Included in mapping were some small areas of shallow coarse-textured soils and a few gravel pits.

These somewhat poorly drained soils commonly are too wet for spring tillage. Most cultivated crops require drainage, which is difficult to provide. Some plant nutrients are not readily available because the surface layer is strongly calcareous. These soils have low available water capacity. During summer, when the water table is lowest, crops can suffer from lack of moisture.

Most of the area is used for grazing. Platte soils can be irrigated, but some leveling generally

is needed and a high level of management is required. Trees and shrubs can be grown successfully, and habitat can be developed for wildlife. (Capability units VIw-4 dryland and IVw-4 irrigated; Subirrigated range site; Moderately Wet windbreak suitability group)

Platte-Wann complex, channeled (0 to 2 percent slopes) (2PW).--This mapping unit is composed of about 65 percent Platte soils and 35 percent Wann soils, and is on bottom lands in the Platte River valley. Platte soils are in the lower areas and in long, narrow, abandoned river channels, and Wann soils are on low, narrow ridges. The Platte soils have a profile similar to the one described as representative for the series. The profile of Wann soils is similar to the one described as representative of the series except that the depth to sand and gravel is 20 to 40 inches. Included in mapping were small areas of poorly drained shallow soils and a few gravel pits.

Soils in this complex have low to moderate available water capacity. Depth to the water table ranges from 18 to 42 inches. Where these soils are dryfarmed, droughtiness is a hazard during the summer. Where they are irrigated, maintaining fertility and control of water are the main concerns.

Most of the area is used for grazing. A small acreage is irrigated; small grains and tame grasses are the principal crops. Trees can be grown successfully, and areas can be developed for food and cover for wildlife. (Capability units VIw-4 dryland and IVw-4 irrigated; Subirrigated range site; Moderately Wet windbreak suitability group)

Rough Broken Land, Loess

Rough broken land, loess (30 to 60 percent slopes) (RB) is on the sides of very steep canyons in the southwestern part of the county (pl. III, top). It consists mostly of calcareous, massive, yellowish-brown loess. In some places, on the lower parts of canyon sides, it consists of reddish-brown loess. Catsteps are common. Soil development is limited to a thin, slightly darkened surface layer. This land type is associated with Coly soils. It differs mainly in having a thinner, lighter colored surface layer and in having steeper slopes. Included in mapping were small areas of Holdrege silt loam and Coly silt loam.

Surface runoff is very rapid. The loess has moderate permeability and high available water capacity. It has very low organic-matter content and low natural fertility.

Rough broken land, loess, is used for grazing. It is too steep for cultivation. Planting of trees generally is not practical. These areas provide food and good cover for wildlife. (Capability unit VIIe-1 dryland, not placed in irrigated capability unit; Thin Loess range site; Undesirable windbreak suitability group)

Rusco Series

This series consists of deep, nearly level, moderately well drained soils in shallow depressions on the loess uplands.

In a representative profile, the surface layer is dark-gray silt loam about 7 inches thick. The subsoil is 13 inches thick and is composed of firm, grayish-brown silty clay loam in its upper part and of friable, light-gray silt loam in its lower part. The underlying material is light-gray silt loam that has common brown mottles. It is calcareous below a depth of 36 inches.

Rusco soils have moderately slow permeability and high available water capacity. They have moderate organic-matter content and high natural fertility. The surface layer is neutral, the subsoil and upper part of the underlying material are mildly alkaline, and the lower part of the underlying material is moderately alkaline.

Rusco soils are used mainly for crop production. They can be dryfarmed or irrigated. They also are suited to pasture and trees. Wildlife use the areas as sources of food and cover.

Representative profile of Rusco silt loam, 300 feet north and 0.3 mile west of the southeast corner of sec. 26, T. 8 N., R. 20 W., in a cultivated field:

Ap--0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B2t--7 to 12 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky structure; hard, firm; mildly alkaline; clear, smooth boundary.

B3--12 to 20 inches, light-gray (10YR 7/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; mildly alkaline; few reddish-brown, pipelike concretions; clear, smooth boundary.

C1--20 to 36 inches, light-gray (10YR 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; common, distinct, coarse, brown mottles; massive; slightly hard, friable; mildly alkaline; few reddish-brown, pipelike concretions; abrupt, smooth boundary.

C2--36 to 60 inches, light-gray (10YR 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; common, distinct, coarse, brown mottles; massive; slightly hard, friable; strong effervescence; white lime accumulations; moderately alkaline; few reddish-brown, pipelike concretions.

The A horizon ranges from 7 to 10 inches in thickness and has crumb or weak granular structure. The B2t horizon ranges from 4 to 14 inches in thickness. Depth to lime ranges from 20 to 44 inches.

Lime concretions occur in the C horizon at some places.

Rusco soils are associated with Kenesaw and Holdrege soils. Rusco soils have a B horizon, which is lacking in Kenesaw soils. They have a thinner solum than Holdrege soils and are not so well drained.

Rusco silt loam (0 to 1 percent slopes) (Ru).--This soil is in very shallow depressions on the uplands. Most areas are small, ranging from 5 to 25 acres in size. Included in mapping were small areas of Kenesaw silt loam, 0 to 1 percent slopes.

Surface runoff is very slow. Ponding is a hazard to farming of this soil and causes crop damage or loss about one year in five.

Most of the acreage is cultivated. Corn, sorghum, and wheat are the most common crops. This soil is suited to irrigation, but some filling of low areas is needed to provide surface drainage and prevent flooding. This soil also is suited to growing grasses for pasture and trees in windbreaks. This soil also provides habitat for wildlife. (Capability units IIw-3 dryland and I-3 irrigated; Silty Lowland range site; Moderately Wet windbreak suitability group)

Scott Series

This series consists of deep, nearly level, poorly drained soils in upland depressions that are frequently flooded. They formed in loess.

In a representative profile, the surface layer is about 6 inches thick. The upper part of the surface layer is dark-gray silt loam and the lower part is gray silt loam. The subsoil is about 42 inches thick. Its upper part is very firm, dark-gray silty clay, and its lower part is firm, light brownish gray silty clay loam that is faintly mottled. Below a depth of 48 inches is underlying material consisting of light-gray, distinctly mottled silt loam.

Scott soils have very slow permeability and high available water capacity. They have moderate organic-matter content and moderate natural fertility.

Most of the acreage of Scott soils is left idle. Some is used for pasture but affords only a small amount of grazing. Where the flooding hazard is least severe, a small acreage is cultivated.

Representative profile of Scott silt loam, 50 feet north and 200 feet east of the southwest corner of sec. 2, T. 6 N., R. 17 W.:

A1--0 to 3 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; soft, friable; slightly acid; clear, smooth boundary.

A2--3 to 6 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

B21t--6 to 26 inches, dark-gray (10YR 4/1) silty clay, very dark brown (10YR 2/2) when moist; moderate, coarse, prismatic structure parting to strong, fine, blocky structure; extremely hard, very firm; many small root channels; few, fine, faint, brown, iron and manganese pellets; neutral; clear, smooth boundary.

B22t--26 to 32 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate, coarse, prismatic structure parting to moderate, medium, blocky structure; extremely hard, firm; neutral; clear, smooth boundary.

B3t--32 to 48 inches, light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; few, medium, faint, yellowish-brown mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; hard, firm; neutral; gradual, smooth boundary.

C--48 to 60 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; common, coarse, distinct, grayish mottles; massive; slightly hard, friable; neutral.

The A horizon ranges from 4 to 10 inches in thickness. The A2 horizon is silt loam or light silty clay loam. The B horizon is 24 to 42 inches thick. The C horizon is light gray, light brownish gray, or pale brown. Depth to lime ranges from 36 to more than 60 inches.

Scott soils are associated with Butler and Holdrege soils. They have a thinner A horizon and thicker B horizon than Butler soils. They have a thinner A horizon and finer textured B horizon than Holdrege soils.

Scott silt loam (0 to 1 percent slopes) (Sc).--This soil is in potholes or depressions that are frequently flooded by runoff from higher areas. Duration of flooding depends mainly on the size of the area and the amount of water received. Areas of this soil range from 5 to 300 acres in size. Included in mapping were small areas of Butler silt loam, depressional.

Flooding is a severe hazard to farming this soil. Unless surface drainage is provided, only about one cultivated crop in 10 years can be grown successfully. Because the surface layer is thin, cultivation commonly incorporates the upper part of the subsoil into the plowed layer. Workability is difficult. This soil dries slowly because its permeability is very slow. Most of the water is lost by evaporation from the soil surface. When the soil is dry, deep cracks extend from the surface into the subsoil.

Most of the acreage is used for whatever grazing it affords. The drier parts of the depressions can be cultivated, particularly if surface drainage is provided. Some of the acreage remains idle and is used by wildlife as a source of food and cover. Trees are not generally suited. (Capability unit IVw-2 dryland, not placed in irrigated capability

unit; not placed in range site; Undesirable windbreak suitability group)

Spoil Banks

Spoil banks (S) consist of soil material that was piled during construction projects. Most areas are adjacent to large irrigation canals, some are around borrow pits, and some are along roads across depressions. The soil material is mostly of loess origin.

Most areas of Spoil banks are fenced off from cultivated fields and are left idle. They are not suitable for crops. Some slopes are so steep that no vegetation is present. Grasses or trees could be established on the more gently sloping areas that are now covered with weeds. These areas provide food and habitat for wildlife. (Capability unit VIIIs-1 dryland, not placed in irrigated capability unit; not placed in range site; Undesirable windbreak suitability group)

Thurman Series

This series consists of deep, nearly level to very gently sloping, somewhat excessively drained soils on stream terraces in the Platte River valley. They formed in alluvial material that was later reworked by wind.

In a representative profile, the surface layer is loamy fine sand about 14 inches thick. It is dark gray in the upper part and grayish brown in the lower part. Beneath it is a transition layer of light brownish-gray, massive, loamy fine sand 14 inches thick. The underlying material is brown loamy fine sand. At a depth of 36 inches is a buried soil that consists of grayish-brown loamy sand underlain by stratified grayish-brown and pale-brown loamy sand and mixed sand and gravel. The upper layer of the buried soil is 6 inches thick, and the lower layer extends to a depth of more than 60 inches. The profile is noncalcareous and neutral.

Thurman soils have rapid permeability and low available water capacity. They have moderately low organic-matter content and low natural fertility.

These soils are used primarily for grazing. If managed carefully, they are suited to either dry-farmed or irrigated crops. Trees are grown successfully in windbreaks. These soils also provide food and cover for wildlife.

Representative profile of Thurman loamy fine sand, terrace, 0 to 3 percent slopes, 300 feet south and 0.2 mile east of the northwest corner of sec. 23, T. 8 N., R. 18 W., in native range:

A11--0 to 8 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) when moist; weak, fine, crumb structure; soft, very friable; few pebbles; neutral; clear, smooth boundary.

A12--8 to 14 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, coarse, blocky structure; soft, very friable; few pebbles; neutral; clear, smooth boundary.

AC--14 to 28 inches, light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; massive; soft, very friable; few pebbles; neutral; gradual, smooth boundary.

C--28 to 36 inches, brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) when moist; massive; soft, very friable; many pebbles; neutral; abrupt, smooth boundary.

Ab--36 to 42 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; single grained; loose; many pebbles; neutral; clear, smooth boundary.

IIACb--42 to 46 inches, grayish-brown (10YR 5/2) coarse sand and gravel, very dark grayish brown (10YR 3/2) when moist; single grained; loose; neutral; abrupt, smooth boundary.

IIIC1--46 to 52 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; few, faint, coarse, yellowish-brown mottles; single grained; loose; many pebbles; neutral; abrupt, smooth boundary.

IVC2--52 to 60 inches, pale-brown (10YR 6/3) mixed coarse sand and gravel, brown (10YR 5/3) when moist; single grained; loose; neutral.

The A horizon ranges from 7 to 19 inches in thickness and has crumb or weak granular structure. The AC horizon is 10 to 18 inches thick. The loamy fine sand material is 40 to 60 inches thick over mixed sand and gravel. Buried profiles resembling the modern Meadin soils are common in these soils in Phelps County.

Thurman soils are associated with Meadin and O'Neill soils and the terrace phase of the Anselmo series. They are deeper over sand and gravel than O'Neill or Meadin soils, and the upper part of the underlying material is coarser textured than in soils of the Anselmo or O'Neill series.

Thurman loamy fine sand, terrace, 0 to 3 percent slopes (2Th).--This is on stream terraces in the Platte River valley. Included in mapping were small areas of Meadin loamy sand, terrace, 0 to 2 percent slopes, and Anselmo fine sandy loam, 0 to 3 percent slopes.

Surface runoff is slow. The surface layer tends to become loose when dry. Where this soil is cultivated, soil blowing and droughtiness are hazards. The organic-matter content and fertility need to be increased. Where this soil is irrigated, maintaining fertility and loss of water by deep percolation are concerns.

Most of the acreage is in native range or in introduced pasture grasses. However, this soil is suited to dryland or irrigated crops. Trees are grown successfully in windbreaks. The soil can be developed as habitat for wildlife. (Capability units IIIe-5 dryland and IIIe-5 irrigated; Sandy range site; Sandy windbreak suitability group)

Valentine Series

This series consists of deep, nearly level to strongly sloping, excessively drained soils on uplands. These soils are coarse textured and they formed in sand that had been reworked by the wind.

In a representative profile, the surface layer is grayish-brown loamy sand about 5 inches in thickness. Beneath it is a transition layer of grayish-brown, loose, loamy sand that is 7 inches thick. The underlying material, to a depth of more than 60 inches, is pale-brown fine sand.

Valentine soils have rapid permeability and low available water capacity. They have low organic-matter content and low natural fertility. The surface layer is neutral, and the transition layer and underlying material are mildly alkaline.

Valentine soils are used nearly entirely for range. A few small areas have been cultivated and later reseeded to grasses.

Representative profile of Valentine loamy sand, 0.4 mile south of the northwest corner of sec. 27, T. 8 N., R. 18 W., in native range:

A1--0 to 5 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; weak, fine, crumb structure; loose; neutral; clear, smooth boundary.

AC--5 to 12 inches, grayish-brown (10YR 5/2) loamy sand, brown (10YR 5/3) when moist; single grained; loose; neutral; mildly alkaline; clear, smooth boundary.

C--12 to 60 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grained; loose; mildly alkaline.

The A horizon ranges from 2 to 7 inches in thickness. It is slightly acid to neutral in reaction. The AC horizon is loamy sand or fine sand and ranges from 4 to 10 inches in thickness. It is slightly acid to mildly alkaline. The C horizon is neutral to mildly alkaline. Mixed sand and gravel is at depths of 4 to 10 feet beneath the surface.

Soil reaction is one class above the upper limit of the defined range for the series. The usefulness and behavior of the soil are not affected.

Valentine soils are associated with Anselmo, Kenesaw, Thurman, and Meadin soils. They are coarser textured than Anselmo or Kenesaw soils and lack the B horizon of those soils. They have a thinner A horizon than Thurman soils. The depth to mixed sand and gravel is greater than in Meadin soils.

<u>Valentine loamy sand</u> (1 to 17 percent slopes) (VcB).--This soil occurs as low hills, ridges, or hummocks on uplands. Swales and small pockets are common in the landscape (pl. III, bottom). Included in mapping were small areas of Meadin loamy sand, terrace, 0 to 2 percent slopes, Anselmo fine sandy loam, 0 to 3 percent slopes, and Anselmo fine sandy loam, hummocky. A few blowouts, or areas affected by severe soil blowing, were included.

This soil is too loose and coarse textured to be cultivated successfully. Most areas that have been cultivated have since been reseeded to native grasses. The soil is droughty; and where tilled, soil blowing is severe. Active blowouts need attention to prevent damage to surrounding vegetation. Good range management is needed to keep the grasses vigorous and to prevent soil blowing.

Nearly the entire acreage is in native grasses and is used as range. If properly planted, certain conifers can be grown successfully. (Capability unit VIe-5 dryland, not placed in irrigated capability unit; Sands range site; Very Sandy windbreak suitability group)

Wann Series

This series consists of deep and moderately deep, nearly level, somewhat poorly drained soils on bottom lands in the Platte River valley. They formed in alluvium and are deep and moderately deep over mixed sand and gravel. The water table fluctuates between depths of 2 and 5 feet.

In a representative profile, the surface layer is dark-gray loam about 10 inches thick. The underlying material, 38 inches thick, is light brownish-gray very fine sandy loam in the upper part, grayish-brown mottled sandy loam in the middle part, and grayish-brown mottled stratified loam, fine sandy loam, and loamy fine sand in the lower part. At a depth of 48 inches is a dark-gray buried soil of mottled clay loam. Beneath it, to a depth of 60 inches, is grayish-brown mottled very fine sandy loam.

Wann soils have moderately rapid permeability and high available water capacity. They have moderate organic-matter content and medium natural fertility. The surface layer is slightly alkaline, and the upper part of the underlying material is moderately alkaline.

Wann soils are used mainly for cultivated crops. Some acreage is in native grasses and is used for grazing or as hay land. Trees are grown successfully in windbreaks. These soils also provide habitat for wildlife.

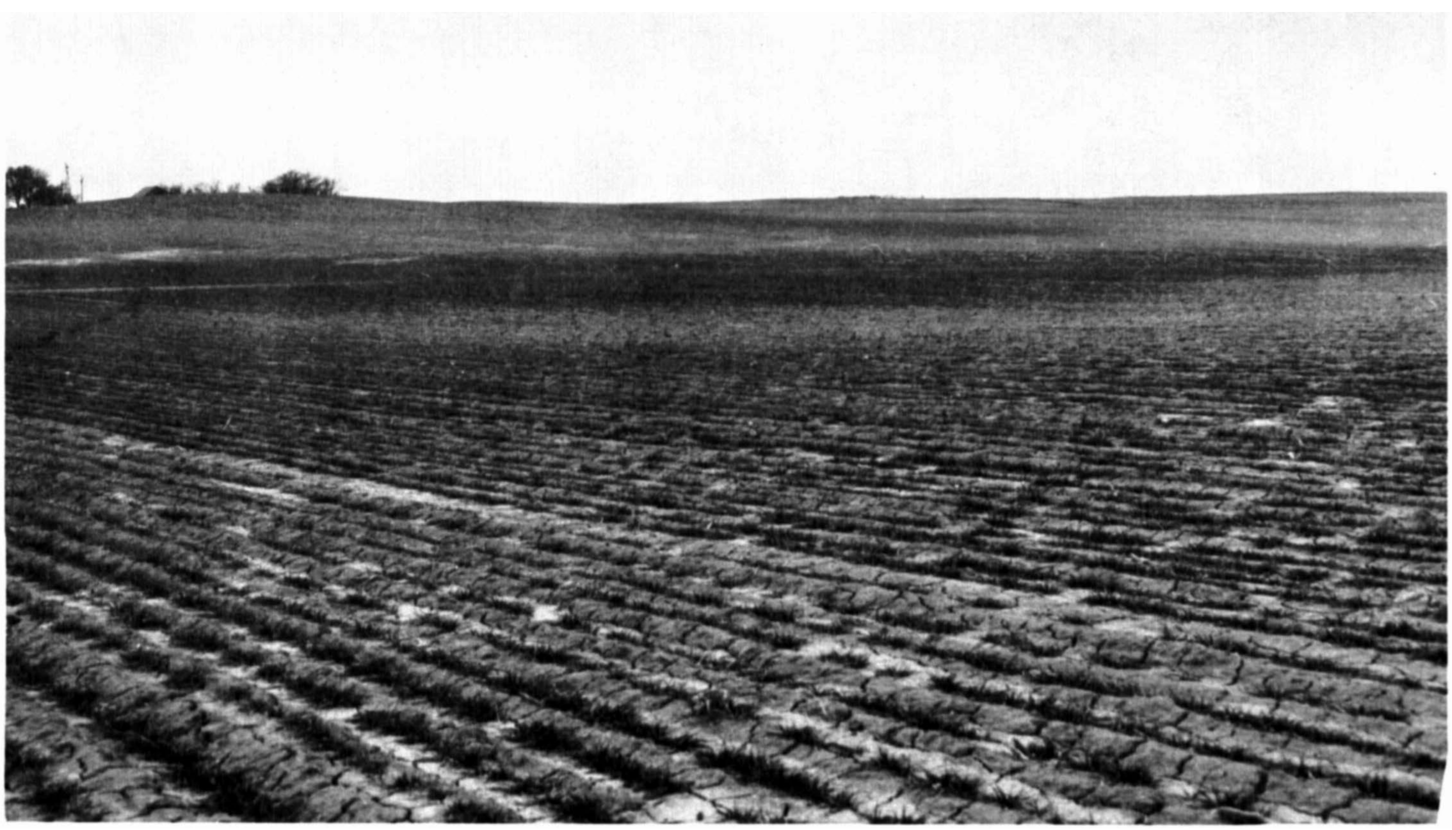
Representative profile of Wann loam, 0.3 mile south and 150 feet west of the northeast corner of sec. 14, T. 8 N., R. 19 W., in a cultivated field:

Ap--0 to 6 inches, dark-gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; slightly hard, friable; slight effervescence; slightly alkaline; abrupt, smooth boundary.

A1--6 to 10 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard, friable; strong effervescence; slightly alkaline; clear, smooth boundary.

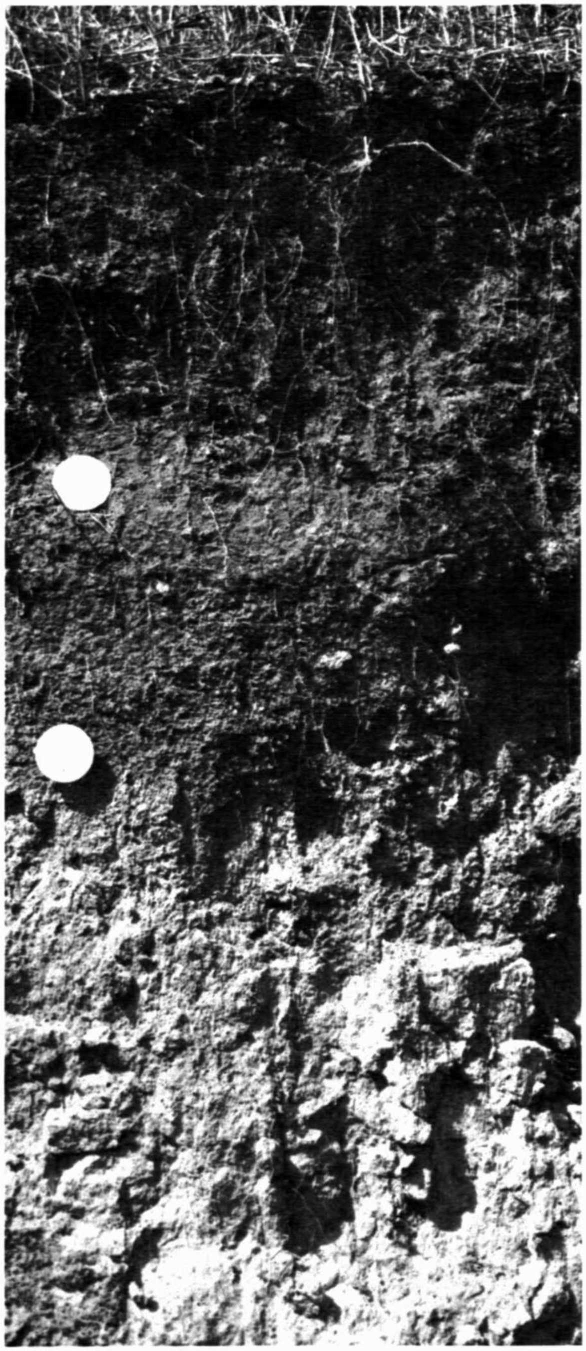
C1--10 to 14 inches, light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.

Typical area of Coly silt loam, 10 to 30 percent slopes, in southwestern part of Phelps County.



Field showing Kenesaw and Coly silt loams, 1 to 3 percent slopes. Light areas are Coly soil and dark areas are Kenesaw.

Holdrege silt loam, a deep soil that formed in wind-blown material. Area between arrows is finer textured part of subsoil.



Kenesaw silt loam, showing moderately thick surface layer and rapid gradation to light-colored material. White dots indicate, respectively, bottom of surface layer and bottom of transitional layer.

Meadin loamy sand, an
having sand and gravel
White dots show, respec
layer and bottom c

Rough Broken land, loess, is used exclusively for grazing.

Valentine loamy sand is well suited to use as range.

Three rows of redcedar on windward side of a seven-row farmstead windbreak. The soil is Holdrege silt loam.

Roadcut in Peoria loess, the parent material for most soils on the central loess plain. Coly, Holdrege, Detroit, and Butler soils are examples of soils that formed in this material.

C2--14 to 24 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.

C3--24 to 34 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C4--34 to 48 inches, grayish-brown (10YR 5/2) stratified loam, fine sandy loam, and loamy fine sand; dark grayish brown (2.5Y 4/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; soft, very friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIAlb--48 to 52 inches, dark-gray (10YR 4/1) light clay loam, black (10YR 2/1) when moist; common, medium and coarse, distinct, brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; massive; hard, firm; violent effervescence; many small pebbles; moderately alkaline; clear, smooth boundary.

IIACb--52 to 60 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; common, medium and coarse, distinct, brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; many small pebbles; slightly alkaline.

The A horizon ranges from 7 to 15 inches in thickness. It is loam or fine sandy loam. The underlying material is sandy loam or fine sandy loam that is commonly stratified with lenses and layers of loam and loamy sand. In most places a dark buried soil layer is between depths of 20 and 50 inches. Soil mottling is distinct or prominent in the underlying material. Depth to mixed sand and gravel is generally between 40 and 72 inches. Wann soils in mapping unit 2PW are only 20 to 40 inches thick over mixed sand and gravel.

Wann soils are associated with Leshara, Grigston, Platte, and Cass soils. They have coarser underlying material than Leshara and Grigston soils and are deeper over sand and gravel than Platte soils. Depth to the water table is less in Wann soils than in Cass or Grigston soils.

Wann fine sandy loam (0 to 1 percent slopes) (Wb).--This soil is on bottom lands adjacent to channels of the Platte River. Its profile is similar to the one described as representative of the Wann series except that the surface layer is fine sandy loam. Included in mapping were small areas of Wann loam and Leshara silt loam.

Surface runoff is slow. This soil is commonly too wet during spring months to allow for timely seedbed preparation. Where this soil is dryfarmed, it is droughty in late summer, when the water table is lowest. Phosphorus is not readily available because lime is present in the surface layer.

This soil is suited to both dryfarming and irrigation. Corn, sorghum, wheat, and alfalfa are the most common crops Trees can be grown successfully in windbreaks. The soil also provides habitat for wildlife. (Capability units IIw-6 dryland and IIw-6 irrigated; Subirrigated range site; Moderately Wet windbreak suitability group)

Wann loam (0 to 1 percent slopes) (Wm).--This soil constitutes a major part of the bottom lands in the Platte River valley. Its profile is the one described as representative of the series. Included in mapping were small areas of Cass fine sandy loam, Leshara silt loam, and areas where the soil is only 20 to 40 inches thick over mixed sand and gravel.

Wetness during early spring months is the main hazard where this soil is cultivated. In places where soluble salts have accumulated in this soil, crops are stunted. In late summer, when the water table is lowest, the soil is droughty. Shallow natural drains are common. These need to be filled before the soil can be successfully irrigated by gravity systems. Some plant nutrients are unavailable because so much lime is present.

This soil is suited to both dryfarming and irrigation. The main crops are corn, alfalfa, grain sorghum, and wheat. A large acreage is still in native grasses and is used for producing hay crops. Trees are grown successfully in windbreaks. The soil also provides habitat for wildlife. (Capability units IIw-4 dryland, IIw-4 irrigated; Subirrigated range site; Moderately Wet windbreak suitability group)

Wann loam, saline (0 to 1 percent slopes) (2Wm).--This soil is on bottom lands adjacent to shallow natural drains. Its profile is similar to the one described as representative of the series except that in some places saline and alkali salts are present in the surface layer or upper part of the underlying material. The water table is at depths of 2 to 4 feet, or slightly higher than in areas that are not affected by salinity. Included in mapping were small areas of Wann loam, Wann fine sandy loam, and some areas where the soil is strongly saline or strongly alkaline.

Salinity is the main hazard where this soil is farmed. Because of the salinity, some nutrients are not available to crop plants and intake of moisture by plant roots is reduced. Crop plants generally are stunted and crop production is lower than in nonsaline soils. In some years seed-bed preparation is delayed by wetness during early spring months. Surface intake rate of moisture is slow.

Most of the acreage is cultivated. Alkali-tolerant crops such as sugar beets and barley are well suited. Wheat, corn, grain sorghum, and alfalfa are also grown. This soil is well suited to irrigation. A small acreage is in native range or planted to introduced grasses. Trees and shrubs

that are tolerant to moderate salinity or alkalinity can be grown successfully in windbreaks. This soil provides habitat for wildlife. (Capability units IVs-1 dryland and IIIs-1 irrigated; Saline Subirrigated range site; Moderately Saline-alkali windbreak suitability group.

USE AND MANAGEMENT OF THE SOILS

This section explains how the soils in Phelps County can be used. It begins with a general discussion of management practices on dryland and irrigated soils. This is followed by an explanation of the capability classification used by the Soil Conservation Service and a grouping of the soils into units according to that classification. Information on the yields of the principal dryfarmed and irrigated crops under prevailing conditions and under improved management then is given for each arable soil. Next, management of rangeland is discussed and soils are grouped into range sites, each of which is a distinctive type of rangeland. There follows a discussion of the suitability of soils for growing trees, particularly in windbreaks. Information also is presented on the capacity of the soil associations to produce food and cover for wildlife. The section concludes with a discussion of the engineering properties of soils, a description of the systems used in classifying soils for engineering purposes, and interpretations of engineering test data for each of the soil series.

Managing the Soils for Crops [2/]

About 72 percent of Phelps County is used for growing crops. According to the annual Nebraska agricultural statistics the most important crops in 1964 were corn (76,030 acres), winter wheat (51,750 acres), sorghum (35,300 acres), and alfalfa (18,410) acres). Other crops (6,690 acres) were rye, oats, barley, soybeans, sugar beets, and wild hay. The rest of the cropland was fallow or in crop diversion and conservation programs.

General Management of Dryland Soils

In Phelps County, the most important dryland crops are wheat, sorghum, and corn. Small acreages of rye, oats, and barley are also grown without irrigation. In 1964, the dryfarmed areas totaled about 99,000 acres.

The sequence of crops grown on a field, in combination with the practices needed for the management and conservation of the soil, is known as a cropping system. On dryfarmed soils, the cropping system should preserve tilth and fertility; maintain a plant cover that protects the soil from erosion; and control weeds, insects, and diseases. Cropping systems vary according to the soils on which they are used. For example, the crop sequence on an eroded Anselmo soil that has a moderate degree of slope should include a high percentage of grass and legume crops, but on Holdrege silt loam, 0 to 1 percent slopes, the system should include a low percentage of grasses and legumes.

For dryland farming, soils need to be worked to prepare a seedbed, to control weeds, and to provide a favorable place for plants to grow. Excessive tillage, however, breaks down the structure of such soils as the Holdrege and Hord. Steps in the cultivation process should be limited to those that are essential. A reduction in tillage, for example, reduces cost of crop production.

In Phelps County, the till-plant method is well suited to row crops. Grasses can be established by drilling into a cover of stubble without further seedbed preparation. Wheat is usually planted in the fall on land that has been summer fallowed. As protection against soil blowing and erosion by water during the fallow period and during the initial growth stage of the wheat, part of the previous crop residue needs to be retained on the surface. The process of tilling the soil and leaving residue on the surface during the fallow period is called stubble mulching. The amount of residue needed to protect the soil depends on the kind of residue, the kind of soil, and the exposure of the field to wind damage.

All crop residue needs to be retained to protect the soil from blowing and from erosion by water and to provide organic matter that can be returned to the soil. Cropping systems need to include crops that produce a good supply of long-lasting residue. Wheat, sorghum, and corn stubble provide good protection for the soil. Proper residue management is particularly important on moderately coarse textured soils, such as the Anselmo fine sandy loams and Cass fine sandy loam. The removal of crop residue by burning is not a desirable practice.

To control water erosion and to conserve moisture that would otherwise be lost on moderately sloping soils, ridge terraces can be constructed across slopes. The resulting furrows hold rain water and thus decrease runoff and erosion. The additional water is absorbed by the soil, becomes available to crops, and improves productivity. Terraces serve as guidelines for tilling and planting. This cultivation across slope is known as contour farming. Terracing and contour farming are well suited to such soils as Holdrege silt loam, 3 to 7 percent slopes, eroded, and Kenesaw and Coly silt loam, 1 to 3 percent slopes. Less power is required for contour tilling than for tilling up and down hills.

Where conservation of moisture is needed on very gently sloping and gently sloping soils, level

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[2/] By E. O. PETERSON, conservation agronomist, Soil Conservation Service.

terraces can be constructed. The horizontal distance between terraces is determined by the slope and kind of soil. Terraces of the gradient type are used in some places. These require grassed waterways for the disposal of surplus water. Where large drainage areas need to have the runoff diverted, large grassed terraces called "diversions" are used. These also require grassed waterways for the disposal of surplus water.

Dryfarmed crops do not need as much fertilizer as irrigated crops. Many of the soils in Phelps County need nitrogen, and some benefit from phosphorus, but most have a neutral reaction in the surface layer and do not need lime. The kind and amount of fertilizer required should be determined by soil tests, field trials, and the needs of the crop to be grown.

Crops now dryfarmed in the county are well suited to the soils and climate, and the potential for new suitable crops is good. Transporation facilities are adequate for handling new crops, provided markets in the larger population centers are available.

General Management of Irrigated Soils

Corn is the most important irrigated crop in Phelps County. Alfalfa, grain sorghum, forage sorhgum, and some sugar beets, oats, barley, soybeans, and grasses are also irrigated. In 1964, the irrigated areas totaled about 88,600 acres.

Irrigation is practiced mainly on the level tableland in the central part of the county. Water for irrigation is obtained from wells and open canals and is distributed by furrows, corrugations, controlled flooding systems, or sprinklers. Different methods of distribution are suited to different crops and to different soils. If gravity irrigation is used, some land leveling is usually needed for more efficient use of the water. Sprinkler systems can be used efficiently on nearly level to gently sloping surfaces such as those of the Thurman and the moderately coarse textured Anselmo soils.

The method of irrigation usually is changed when converting from a row crop to a close-growing crop. Because this change is difficult on slopes greater than 2 percent, some farmers bench level their land so that the slope of the bench is less than 1 percent. Bench leveling is well suited to the gently and very gently sloping phases of the Holdrege and Kenesaw silt loams. When leveling the shallow Meadin soils and the moderately deep O'Neill soils, care needs to be taken not to expose the underlying sand and gravel, which is poorly suited to cultivation.

On irrigated land, erosion by water can be controlled only by careful planning. Terracing and contour farming on moderate slopes and bench leveling on gentle slopes provide effective control. Close-growing crops such as alfalfa and small grains tend to hold the soil in place better than row crops. Plowing under crop residue and green manure crops, adding barnyard manure, and using a stubble-mulch system of farming each help to keep water erosion to a minimum. Soils that can benefit from some or all of these practices are Holdrege silt loam, 3 to 7 percent slopes, and Coly and Kenesaw silt loams, 7 to 10 percent slopes. Crop residue left after harvesting conserves moisture in the soil and helps prevent soil blowing late in fall and in winter. Leaving crop residue is particularly important on the weak-structured Anselmo, Thurman, Cass, and Kenesaw soils.

Because irrigated soils produce larger yields than dryfarmed soils, more plant nutrients are removed from the soil when irrigation is practiced. To keep irrigated soils fertile, crop residue should be returned to the soil, and mineral fertilizers can be added to replace lost nutrients. Nitrogen is commonly needed for nonlegume crops. Phosphorous can be added to the somewhat poorly drained Leshara, Platte, and Wann soils, and zinc can be applied to eroded surfaces, such as that of Holdrege soils, 3 to 7 percent slopes, severely eroded. The kind and amount of fertilizer needed for specific crops need to be determined on the basis of soil tests.

Salinity is a hazard in the saline phases of the Leshara and Wann soils. Sulfur and gypsum can be used to help neutralize the salts, but this method is expensive and the results commonly are disappointing. Careful land leveling can reduce salinity by improving surface drainage, but the most satisfactory method of coping with salinity is to adjust the cropping system to crops that are tolerant of the existing salts.

Crops now irrigated in the county are well suited to the soils and climate, and there is a ready market for the products. The total acreage of irrigated crops can be increased by using sprinkler systems on moderately coarse textured and coarse textured soils. Additional irrigation also can be developed on the silty soils where sufficient water is available. Where economic factors are favorable, the potential for increased irrigation is present.

Farmers needing technical help in planning irrigation developments can contact the local office of the Soil Conservation Service and the county agricultural agent. Information about costs and equipment can be obtained from equipment dealers.

Capability Grouping

Capability grouping is a system of classification the Soil Conservation Service uses to show, in a general way, the suitability of soils for most kinds of field crops. The groupings are made according to the limitations of the soils when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management. For a complete explanation of the capability classification, see

USDA Handbook No. 210, "Land Capability Classification" (5)

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soils are grouped at three levels. the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife. (There are no Class V soils in Phelps County.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe. The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by w, s, and c, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 or IIIe-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by Capability Units

In the following pages the capability units in Phelps County are described and suggestions for the use and management of the soils are given.

Dryfarmed soils and irrigated soils need different management practices. For this reason, dryfarmed soils are in different capability units than soils that are suitable for irrigation. If the symbol for a capability unit is followed by the word "dryland," the soils in that unit are dryfarmed, and if the symbol is followed by the word "irrigated," the soils are suitable for irrigation.

Each of the dryland and irrigated capability units is described on the following pages. If a dryland and an irrigated capability unit consist of the same soil or soils, their descriptions are combined. The soils and their common features are given first. Then dryland and irrigation management practices are described. Crops suited to the kind of management are given, and hazards and limitations are described together with practices that help to overcome them.

Capability Units I-1 Dryland and I-1 Irrigated

Grigston silt loam is the only soil in these units. It is a deep, well-drained, nearly level soil that has moderate organic-matter content, high natural fertility, and a high available water capacity. The surface layer is medium textured. The underlying material is mainly medium textured but contains thin layers of moderately fine textured or moderately coarse textured material in places. This soil is neutral in its upper part and mildly alkaline to moderately alkaline in its lower part. It is easily worked, and it is one of the best soils in the county for farming.

Dryland management.--Corn, alfalfa, and wheat are the most common dryfarmed crops. A small acreage in tame grasses is used for pasture. This soil is also suitable for windbreaks.

If fertility is maintained, this soil can be cultivated intensively. In some years crops benefit from commercial fertilizer, particularly nitrogen. Cultivated areas are rarely subject to erosion by water but are subject to soil blowing where not protected. Crop residue can be used to prevent blowing and crusting of the surface layer and to reduce loss of moisture through evaporation. Use of grasses and legumes in the crop seauence helps to control insects and plant disease. Planting on grassed field borders, turn rows, and roadways helps to control weeds, provides winter pasture, and is a source of hay. This soil provides habitat for wildlife.

Irrigation management.--Corn, sorghum, small grain, alfalfa, soybeans, sugar beets, and grasses are the principal irrigated crops. Rye and barley are grown in smaller amounts.

Little or no leveling is needed to prepare this soil for gravity irrigation. Loss of fertility is a greater hazard than when crops are dryfarmed because irrigation water leaches nutrients from the soil. Fertility can be maintained through addition of commercial fertilizer and barnyard manure and by returning crop residue to the soil. Waste of irrigation water can be reduced by careful timing of applications and by applying no more water than is needed. Irrigation runs should be no longer than necessary.

Capability Units IIc-1 Dryland and I-2 Irrigated

These units consists of deep, well-drained, nearly level soils in the Anselmo, Cozad, Detroit, Hobbs, Holdrege, Hord, and Kenesaw series. Their surface layer is medium textured, and their subsoil and underlying material are medium to moderately coarse textured. They are on alluvial terraces, colluvial foot slopes, and uplands. The available water capacity of the Anselmo soils is moderate, and that of the other soils is high. The soils of these capability units have moderate to moderately rapid permeability and medium to high natural fertility. Surface runoff is slow.

Dryland management.--Corn, grain sorghum, alfalfa, and wheat are the most common dryfarmed crops. Some forage sorghum also is grown. These soils are suited to tame grasses and trees. They provide habitat for wildlife.

Limited rainfall is the main hazard to crop production under dryland management. Cultivated areas are subject to soil blowing where not protected. Summer fallowing helps to store moisture for use by crops. Maintaining crop residue on the surface helps to reduce soil blowing and increases the capacity of the soils to take in moisture. Wind stripcropping and alternating strips of crop and fallow also help to reduce soil blowing. Grasses and legumes in the cropping sequence aid in erosion control. Crops generally benefit from nitrogen fertilizers in wet years.

Irrigation management.--Corn, grain sorghum, soybeans, and alfalfa are the main irrigated crops. Forage sorghum, small grain, sugar beets, and tame grasses are grown in smaller amounts. These soils provide food and cover for wildlife.

Maintenance of fertility and proper control of irrigation water are the main concerns. Soil blowing can occur if the soils are not protected. Fertility can be maintained if commercial fertilizers, barnyard manure, and green-manure crops are applied. Returning crop residue aids in keeping the soils friable and fertile and helps prevent soil blowing. Some land leveling generally is needed to permit efficient use of irrigation water. Application of irrigation water needs to be timely and in proper amounts. Loss of water at the ends of field rows should be kept to a minimum.

Capability Units IIe-1 Dryland and IIe-1 Irrigated

These units consist of deep, well-drained, very gently sloping soils of the Holdrege and Kenesaw series. The surface layer is medium textured, the subsoil is medium textured to moderately fine textured, and the underlying material is medium textured. These soils are on alluvial terraces and uplands, and they are friable and easy to cultivate. They have moderate permeability, high available water capacity, and medium to high natural fertility. Surface runoff is slow to medium. These soils are well suited to cultivation.

Dryland management.--Wheat, grain sorghum, and corn are the most common dryfarmed crops. Oats, barley, alfalfa, and forage sorghum also are grown. These soils are suited to grasses and trees. They also provide food and cover for wildlife.

Lack of adequate moisture limits crop production in most years. Contour farming conserves moisture and helps to protect against erosion by water. Stubble mulching and minimum tillage also help to conserve moisture and to control erosion. Grassed waterways can be used with terraces. Some cover crops should be included in the cropping sequence. Crops benefit from nitrogen fertilizer, particularly in years of above-average rainfall.

Irrigation management.--These soils are well suited to irrigation. Corn, grain sorghum, and alfalfa are the principal crops. Forage sorghum, sugar beets, soybeans, and tame grasses also are grown.

Maintenance of fertility, control of water erosion and soil blowing, and control of irrigation water are the main concerns. Fertility can be maintained if commercial fertilizers and barnyard manure are applied. Organic-matter content can be maintained by the return of crop residue to the soils. Water erosion is less where row crops are grown on the contour. Terracing and bench leveling are effective means of erosion control and also aid in conserving moisture.

Capability Units IIe-3 Dryland and IIe-3 Irrigated

These units consist of deep, well-drained, nearly level to very gently sloping soils of the Anselmo and Cass series. They have a moderately coarse textured surface layer and generally are coarser with depth. These soils are on bottom lands and uplands, and they are easy to cultivate. They have moderately rapid permeability and moderate available water capacity. Their organic-matter content is moderately low, and their natural fertility is medium. Surface runoff is slow.

Dryland management.--Corn, grain sorghum, wheat, alfalfa, and tame grasses are the main crops. Some oats and rye also are grown. These soils are suited to tame grasses and trees, which provide habitat for wildlife. Soils in these units can be tilled over a wide range of moisture content, and they warm up earlier in the spring than finer textured soils.

Soil blowing is a hazard where these soils are cultivated. Inadequate moisture limits crop production in many years. Lack of available phosphorus and nitrogen lowers fertility. Wind stripcropping, stubble mulching, planting of cover crops, and establishment of windbreaks help to prevent soil blowing. In some places, contour farming and terracing can control water erosion. Minimum tillage, legumes in the cropping sequence, and return of crop residue to the soil increase the organic-matter content. Commercial fertilizer can supply needed amounts of phosphorus and nitrogen.

Irrigation management.--Corn, grain sorghum, alfalfa, soybeans, and sugar beets are the main irrigated crops. To some extent, forage sorghum and tame grasses also are grown.

Fertility maintenance, prevention of soil blowing, and proper control of irrigation water are the main concerns. Erosion by water can be a hazard in sloping areas. Nitrogen fertilizer must be applied for sustained production. Phosphorus also is needed in some fields. Legumes should be included in the cropping sequence. The moderately coarse textured surface layer needs the protection of either a growing crop or organic residue. Planting cover crops or crops that have a high residue, stubble mulching, wind stripcropping, and establishing field windbreaks are ways to control soil blowing. Some land leveling generally is needed for gravity irrigation.

Capability Units IIs-2 Dryland and IIs-2 Irrigated

These units consist of the deep, nearly level, claypan soils of the Butler and Crete series. These soils have a medium-textured surface layer, a fine-textured subsoil, and medium-textured underlying material. Butler soils are somewhat poorly drained, whereas Crete soils are moderately well drained.

The soils of these capability units are on uplands. The surface layer is thick, friable, and easily worked. It absorbs water readily. The subsoil has slow permeability and becomes very hard when dry. Movement of air and water through it is very slow, and penetration by roots is inhibited. These soils have high available water capacity, high natural fertility, and moderate organic-matter content. They become droughty during dry weather. Surface runoff is slow.

Dryland management.--Wheat, sorghum, alfalfa, and tame grasses are the most common crops. Wheat is particularly well suited because it matures before the hot, dry summer weather. Sorghum is usually more productive than corn.

Dry weather can result in burning of crops, because the claypan limits effective water storage. Even though the soils are deep, the effective rooting depth is shallow in dry weather. Grasses and legumes in the cropping system help to keep the subsoil open and to make water penetration easier. Stubble mulching helps improve tilth and reduces evaporation. Barnyard manure increases the supply of organic matter and improves fertility. Nitrogen is needed to maintain the productivity of crops other than legumes.

Irrigation management.--Corn and grain sorghum are the principal irrigated crops. Soybeans, forage sorghum, sugar beets, alfalfa, and tame grasses also are grown.

Fertility maintenance and water management are the main concerns. Additions of commercial fertilizer, particularly nitrogen and phosphorus, are needed. Barnyard manure and green-manure crops help to maintain good tilth and fertility and increase the capacity of the soils to absorb water. Legumes or grass-legume mixtures in the cropping sequence help to keep the subsoil open and result in better penetration by moisture. Some land leveling generally is necessary if irrigation water is to be managed efficiently. Care needs to be taken not to expose the very firm subsoil. This layer is difficult to plow and cultivate, and crops do not respond well when it is at the surface. Crop response to irrigation is excellent.

Capability Units IIw-3 Dryland and I-3 Irrigated

Rusco silt loam is the only soil in these units This nearly level, moderately well drained soil is in shallow upland depressions. The surface layer is medium textured, and the subsoil is moderately fine textured. This soil is easily worked. It absorbs moisture well and releases it slowly to plants. The subsoil restricts the movement of air and water. It also inhibits the growth of plant roots, particularly during dry weather. Surface runoff is slow.

Dryland management.--Corn, grain and forage sorghums, alfalfa, and wheat are the main dryfarmed crops.

Flooding early in the growing season is the main hazard, and maintenance of fertility is a concern. About one crop in five is lost because of surface ponding. The most severe losses are in the lowest parts of the depressions. Some ponding can be relieved by V-ditches. Terraces and diversions will keep much excess water off the low areas if the water can be diverted to a suitable outlet. When

crops are tall, as they are late in summer, they can benefit by being flooded for short periods.

Fertility and tilth can be maintained by including legumes and grasses in the cropping sequence and by returning crop residue to the soil. Crops benefit from commercial fertilizer, mainly nitrogen.

Irrigation management.--Corn, sorghum, alfalfa, sugar beets, and tame grasses are the irrigated crops on this soil.

Maintenance of fertility and management of water are the principal concerns. Alfalfa, grass, or a legume-grass mixture in the cropping sequence helps to maintain fertility, tilth, and organic-matter content. Other crops need additions of nitrogen. Building diversion terraces and establishing proper grade by leveling helps to reduce ponding in the lower parts of the depressions. Efficient irrigation includes timely applications of water, regulation of amounts applied, and control of waste water.

Capability Units IIw-31 Dryland and IIw-3 Irrigated

Hobbs silt loam is the only soil in these units. It is a deep, nearly level to very gently sloping soil that is medium textured throughout its profile. It occurs on bottom lands in narrow canyons and on flood plains of intermittent streams. Most of these areas are long and narrow. The surface layer is very thick.

This soil is well drained internally but is flooded occasionally. Flooding adds soil material to the surface but also can drown out some crops. About one crop in five is lost because of flooding. This soil is easily worked, and it absorbs and releases water readily to plants. It has moderate permeability and high available water capacity. Natural fertility is high, and organic-matter content is moderate.

Dryland management.--Corn, sorghum, wheat, alfalfa, and tame grasses are suitable dryfarmed crops.

Flooding is the main hazard. It sometimes delays planting in the spring, and it can damage crops by scouring or by depositing soil and debris. Crops can benefit, however, by shallow flooding for short periods in middle or late summer. Diversion terraces help to keep floodwater off the soil. Drainage ditches satisfactorily remove excess water in some places. Legumes or grass-legume mixtures in the cropping sequence improve fertility and tilth.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are crops suitable for irrigation.

Flooding is the main hazard, but maintenance of fertility and management of water are other concerns. Excess water can delay spring tillage and can drown or damage young crops. Diversion terraces on higher lying areas can be used to keep floodwater off the land. In some places drainage ditches remove part of the excess water. Suitable outlets for water need to be established. Commercial fertilizers, barnyard manure, and green-manure crops can help to maintain fertility. Nitrogen is needed for nonlegume crops.

Capability Units IIw-4 Dryland and IIw-4 Irrigated

These units consist of the deep, somewhat poorly drained soils of the Leshara and Wann series. They are on bottom lands where the depth to water is 2 to 6 feet. The surface layer is medium textured, and the underlying material is medium textured to moderately coarse textured. These soils are calcareous at or near the surface and are easily worked. They absorb water well and release it readily to plants. Permeability is moderate to moderately rapid, and the available water capacity is high. These soils have moderate organic-matter content and medium natural fertility. Surface runoff is slow.

Dryland management.--Corn, wheat, alfalfa, and tame grasses are suitable dryfarmed crops. Trees grow well, and these soils provide food and cover for wildlife. During dry years, deep-rooted crops benefit from the moisture supply available at moderate depth.

Excess wetness commonly delays spring tillage and planting of crops. Alkali conditions exist in some places. Surface drains can help relieve wetness if suitable outlets for the drains are available. Alfalfa and grasses in the cropping sequence aid in maintaining the fertility, tilth, and organic-matter content of the soils.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are the principal irrigated crops.

Excess wetness in spring is the main concern because it delays tillage and planting. Maintaining fertility and tilth are additional concerns. Land leveling is the best way to obtain surface drainage. In some places V-ditches can be used to relieve wetness. Legumes and green-manure crops in the cropping sequence and applications of barnyard manure help to improve tilth and maintain fertility. Legumes respond to phosphorus, and most other crops to nitrogen. Some crops benefit from additions of zinc.

Capability Units IIw-6 Dryland and IIw-6 Irrigated

Wann fine sandy loam is the only soil in these units. It is a deep, nearly level, somewhat poorly drained soil on bottom lands. This soil is calcareous at the surface. Its surface layer and underlying material are moderately coarse textured. The depth to the water table ranges from 2 to 5 feet. This soil is easily worked. It has moderately rapid permeability, high available water capacity, moderate organic-matter content, and medium natural fertility. It absorbs moisture well and releases it readily to plants. Surface runoff is slow.

Dryland management.--Corn, sorghum, wheat, alfalfa, and tame grasses are the most suitable dryfarmed crops. Trees grow well in windbreaks, and this soil provides food and cover for wildlife.

Excess wetness in the spring and soil blowing during dry seasons are the principal hazards. Maintenance of fertility and tilth are concerns. Tillage and planting are commonly delayed by the need for drainage early in the growing season. In some places V-ditches can help remove excess water. Planting wheat or other crops that do not need spring tillage lessens the problem caused by excess wetness. Alfalfa and grasses in the cropping sequence aid in maintaining fertility, in improving tilth and organic-matter content, and in reducing soil blowing. Wind stripcropping and stubble mulching also help to control soil blowing.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are suitable irrigated crops.

This soil is commonly too wet to till or plant at the optimum time. In small areas of alkali accumulation, tilling is difficult and plant nutrients are not so readily available as in areas not affected. When dry and not protected, this soil is subject to wind damage. Surface drainage can be improved by land leveling. In the lowest areas V-ditches can aid in removing excess water. Barnyard manure and phosphorus fertilizer can help to improve the alkali areas. Nitrogen fertilizer is generally needed, and phosphorus is needed for legumes. Additions of zinc can help maintain production. Alfalfa and grass in the cropping sequence help to maintain fertility and tilth. A growing crop or crop residue on the soil helps prevent soil blowing.

Capability Units IIIe-1 Dryland and IIIe-1 Irrigated

These units consist of deep, gently sloping, well-drained soils of the Holdrege, Kenesaw, and Coly series. These soils are on uplands and are easily worked. They have a medium-textured surface layer, a moderately fine to medium textured subsoil, and medium-textured underlying material. Areas of light colored soil are calcareous at or near the surface. The soils of these capability units absorb moisture well and release it readily to plants. They have moderate permeability, high available water capacity, and low to high natural fertility. The organic-matter content in the Holdrege and Kenesaw soils is moderate, and in the Coly soils it is low. These soils have medium surface runoff.

Dryland management.--Corn, wheat, sorghum, alfalfa, and tame grasses are the most common dry-farmed crops. Trees grow well in windbreaks and provide food and cover for wildlife.

These soils are subject to droughtiness, erosion by water, and soil blowing. Maintenance of fertility is a concern. The available moisture can be conserved by using level terraces to reduce surface runoff and by stubble mulching during fallow years to increase intake of water. Level terraces also help to reduce water erosion, and stubble mulching helps to reduce soil blowing. Grassed waterways can be used in some places to lessen water erosion. The cropping system should include cover crops as well as row crops. Catch crops of millet and sorghum can be planted in years when other crops fail because of drought. A legume or grass crop helps to maintain fertility and tilth. Nonlegume crops benefit from additions of nitrogen. Crop residues should not be burned; instead, they should be returned to the soil.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are the main irrigated crops.

Erosion by water is a hazard, and maintenance of fertility and control of irrigation water are concerns. Bench terraces and contour farming help to reduce water erosion. Nonlegume crops benefit from additions of commercial fertilizers, particularly nitrogen. Fertility and tilth are improved by returning crop residue to the soil and by using available barnyard manure and green-manure crops. Some leveling generally is needed to prepare these soils for gravity irrigation.

Capability Units IIIe-11 Dryland and IIe-11 Irrigated

These units consist of deep, well-drained, medium-textured Kenesaw and Coly silt loams, 1 to 3 percent slopes. These soils are on uplands. The Coly soil is calcareous at the surface, is lighter colored, and has less well-defined layers than the Kenesaw soil. These soils are friable and easily worked. They have moderate permeability, high available water capacity, and medium natural fertility. Moisture is released readily to plants. Organic-matter content is low in the Coly soil and moderate in the Kenesaw soil. Surface runoff is slow.

Dryland management.--Wheat, corn, sorghum, alfalfa, and tame grasses are the most common dry-farmed crops. Trees can be grown successfully in windbreaks. These soils provide food and cover for wildlife.

These soils are subject to soil blowing and erosion by water. Crops are damaged by drought during years of below-normal rainfall. Stubble mulching and stripcropping help to prevent soil blowing. Where no growing crop or crop residue protects the soil in the spring, emergency tillage may be needed to stop soil blowing. Terraces and contour farming slow runoff and help to control soil loss.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are the main irrigated crops.

Erosion by water and soil blowing are hazards. Maintenance of fertility and control of irrigation water are concerns of management. Contour farming and construction of bench terraces are ways to

reduce erosion by water. Including legumes and grasses in the cropping sequence and retaining crop residue for cover are ways to control soil blowing. Commercial fertilizers are needed for sustained production of crops. Additions of barnyard manure, planting green-manure crops, and returning crop residues to the land also help to maintain fertility. Land leveling makes possible more efficient use of irrigation water. Pastures of tame grass can be alternately grazed and irrigated.

Capability Units IIIe-3 Dryland and IIIe-3 Irrigated

These units include the gently sloping Anselmo soils and the nearly level O'Neill soils on terraces and uplands. The surface layer and subsoil are moderately coarse textured, and the underlying material ranges from loamy sand to mixed sand and gravel. These soils have moderately rapid permeability, low to moderate available water capacity, moderately low organic-matter content, and medium natural fertility. They are easy to work, and absorb moisture readily. Early cultivation generally is possible because the soils warm up rapidly in spring. Surface runoff is medium on the gently sloping soils and slow on the nearly level soils.

Dryland management.--Corn, sorghum, wheat, alfalfa, and tame grasses are the main dryfarmed crops. Rye and oats are grown in smaller amounts. Trees are grown successfully in windbreaks, and these soils provide habitat for wildlife.

Soil blowing and erosion by water are the main hazards. Conservation of moisture and maintenance of fertility and tilth are important parts of management. Soil blowing can be controlled by using stubble mulch, by wind stripcropping, by planting cover crops of rye, and by establishing field windbreaks. Water erosion and soil loss can be lessened by terracing. Fallowing for one year conserves soil moisture to be used by crops the following year. This practice is used mainly for wheat. Fertilizer, mainly nitrogen, is needed to maintain fertility. Cover crops, such as small grains and legumes, in the cropping sequence aid in maintaining tilth and help to break insect and disease cycles.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are the main irrigated crops.

Soil blowing is a hazard. Maintenance of fertility and proper management of water are needed. A cropping sequence that includes legumes or grasses helps to prevent soil blowing, to maintain fertility, and to improve tilth. Adding barnyard manure, planting green-manure crops, and returning available crop residue to the soil also help to maintain fertility. Nitrogen fertilizer is needed for sustained production of crops. Some land leveling generally is needed for gravity irrigation systems. Bench terraces are suited in some areas. Where deep cuts are made into coarse-textured material, back filling with finer textured soil is desirable. O'Neill soils require frequent applications of irrigation water.

Capability Units IIIe-5 Dryland and IIIe-5 Irrigated

Thurman loamy fine sand, terrace, 0 to 3 percent slopes, is the only soil in these units. It is deep and somewhat excessively drained, and it occurs on an alluvial terrace. The surface layer and underlying material are coarse textured. This soil has rapid permeability, low available water capacity, low organic-matter content, and low natural fertility. It absorbs water well and releases it readily to plants. It also is easy to work and can be cultivated at high moisture levels. Surface runoff is slow because rain is absorbed about as rapidly as it falls.

Dryland management.--Corn, wheat, sorghum, rye, vetch, alfalfa, and tame grasses are suitable dry-farmed crops. Trees are grown successfully in windbreaks, and this soil provides habitat for wildlife.

Soil blowing is a serious hazard where the soil is not protected by a growing crop or a cover of crop residue. In some years lack of sufficient rainfall is an additional serious hazard. Cover crops in the cropping sequence help to prevent soil blowing. Wind stripcropping, stubble mulching, and field windbreaks also are useful for that purpose. Adding barnyard manure and returning crop residue to the soil help to improve fertility and tilth. Fallowing the land in alternate years to store moisture for crop use is a practice well suited to wheat. Terracing is difficult because this soil is so sandy. However, contour farming is practicable where this soil has a slope of about 2 percent.

Irrigation management.--Corn, sorghum, alfalfa, and tame grasses are suited to this soil. Sugar beets and soybeans also can be grown. Trees are grown successfully in windbreaks, and this soil provides habitat for wildlife.

Soil blowing is the principal hazard. Fertility maintenance is necessary for sustained production of crops. Proper management of water is also needed. A cropping sequence that provides cover most of the time helps to decrease soil blowing. Rye and vetch are suitable cover crops. Keeping crop residue on the land and emergency tillage are other methods for reducing soil blowing. Legumes and grasses in the cropping sequence aid in maintaining fertility and tilth. Generally some leveling is needed for proper water management. Where deep cuts are made, fertility can be restored by applying barnyard manure and large amounts of commercial fertilizer. Frequent irrigation is needed.

Capability Units IIIw-2 Dryland and IIs-21 Irrigated

Butler silt loam, depressional, is the only soil in these capability units. It is a deep, nearly

level, somewhat poorly drained soil in shallow upland depressions. It has a medium-textured surface layer; a fine-textured, clayey subsoil; and medium-textured underlying material. Because this soil is in low areas, water ponds on its surface following rains. The surface layer absorbs water readily, but the claypan subsoil has very slow permeability Moisture is released slowly to plants. This soil has high available water capacity, moderate organic-matter content, and high natural fertility. It is easily worked if tilled at the optimum moisture level.

Dryland management.--Corn, sorghum, wheat, and tame grasses are the principal dryfarmed crops.

The main limitations in using this soil are caused by wetness. In many years corn is difficult to cultivate early in spring because the soil is too wet. Sorghum, which can be planted and cultivated later, is better suited than corn. In some years legumes fail because of flooding. Crops that are not seriously damaged by flooding are better suited to this soil. Some small areas can best be used for grass, which provides excellent habitat for upland game birds. Some of the runoff to the depressions can be diverted by terraces constructed on the higher adjacent soils. If suitable outlets can be found, V-ditches will remove excess water.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, sugar beets, and tame grasses are the principal irrigated crops.

Crop damage by flooding is the main hazard. Maintaining fertility and improving tilth are concerns of management. Diversion terraces on higher adjacent soils can reduce runoff to the depressions. If suitable outlets can be found, V-ditches can improve surface drainage. The claypan subsoil restricts downward movement of moisture and also limits its effective root penetration. Leveling by filling low areas with soil material from higher surrounding areas is necessary for irrigation to be successful. Including a legume or grass-legume mixture in the cropping sequence helps to open the soil to air and water. Crop residue can be returned to the soil. Barnyard manure and green-manure crops aid in improving tilth, water intake, and fertility.

Capability Units IVe-1 Dryland and IVe-1 Irrigated

Holdrege silt loam, 7 to 10 percent slopes, is the only soil in these units. It is a deep, moderately sloping, well-drained soil on uplands. The surface layer is medium textured, the subsoil is moderately fine textured, and the underlying material is medium textured. This soil has high available water capacity, moderate organic-matter content, and high natural fertility. It is easily worked, and it absorbs and releases water readily. Surface runoff is medium to rapid, depending on the cover.

Dryland management.--Most areas are in native range, but the soil is suited to cultivated crops if proper conservation practices are followed. Corn, wheat, sorghum, alfalfa, and tame grasses are the main dryfarmed crops. Trees are grown successfully in windbreaks. This soil provides food and cover for wildlife.

Erosion by water is the principal hazard. Maintenance of fertility, loss of water by surface runoff, and soil blowing are concerns. Terraces and contour farming are needed to reduce gullying and loss of soil and water. Grassed waterways commonly are needed with terraces. To keep cultivated soil in place, close-growing crops need to be used during most of the cropping sequence. Alfalfa and legume-grass mixtures help to maintain fertility and furnish hay for livestock. Stubble mulching improves water intake and helps to prevent soil blowing.

Irrigation management.--Hay and pasture crops such as alfalfa and grasses are best suited for irrigation. Wheat and other small grains are suited if sprinklers are used.

Erosion by water, loss of irrigation water, and loss of fertility are the main concerns of management. For irrigation to be successful, some leveling and grading generally is needed. Loss of irrigation water by runoff is not excessive if the water is applied at the proper rate. Terraces can prevent much surface runoff and gullying. Commercial fertilizer is needed to maintain fertility. Alfalfa responds well to phosphorus.

Capability Units IVe-3 Dryland and IVe-3 Irrigated

Anselmo fine sandy loam, 7 to 10 percent slopes, is the only soil in these units. It is a deep, well-drained, moderately sloping soil on uplands. The surface layer, subsoil, and underlying material are all moderately coarse textured. This soil is easily worked. It has moderately rapid permeability, moderate available water capacity, moderately low organic-matter content, and medium natural fertility. Moisture is absorbed and released readily. Surface runoff is medium.

Dryland management.--Wheat, rye, alfalfa, and grasses are the main dryfarmed crops. Although corn and sorghum are grown to some extent, they are not well suited to this soil. Trees are grown successfully in windbreaks. This soil provides habitat for wildlife.

Erosion by water and soil blowing are hazards where this soil is cultivated. Leaching of nutrients is a concern. Some areas of this soil can be terraced to prevent water erosion, but where the land is hummocky, terracing is not practical. Grassed waterways can be used with the terraces. Contour farming also reduces water erosion. Stubble mulching, wind stripcropping, and field windbreaks help to prevent soil blowing. Frequent cover in the cropping sequence is desirable for the same purpose. Returning crop residue to the soil and applying

nitrogen fertilizer help to maintain fertility. Wheat crops benefit from summer fallowing.

Irrigation management.--Alfalfa and tame grasses are the main irrigated crops. Although close-growing small grain crops are suited under sprinkler systems, they are not grown extensively.

Erosion by water and soil blowing are hazards. Leaching of plant nutrients and proper management of water are concerns. Terraces and contour farming help to prevent water erosion but are not practical in hummocky areas. Stubble mulching and wind stripcropping reduce soil blowing. Emergency tillage can be practiced if blowing begins early in spring. Proper fertilization is needed to replace plant nutrients lost by cropping and leaching. Irrigation water needs to be applied at the correct time and in proper amounts to prevent water loss by runoff and yet meet crop requirements.

Capability Units IVe-8 Dryland and IVe-11 Irrigated

These units consist of the gently sloping, severely eroded Holdrege soils and the moderately sloping, eroded soils of the Holdrege-Coly complex. These are deep, well-drained soils on uplands. They have a medium-textured surface layer, subsoil, and underlying material and are lighter colored than most other soils in the county. Erosion has removed much of the original surface layer. Where severely eroded, the soils are calcareous at the surface. Although these soils are friable, tillage is difficult in places where small gulleys are common. Water is absorbed readily but not so readily as by similar soils that are not eroded. These soils have low organic-matter content, medium to low fertility, and high available water capacity. Surface runoff is medium to rapid.

Dryland management.--Wheat, alfalfa, and tame grasses are the most common dryfarmed crops. A small acreage is used for growing corn and sorghum. Trees are grown successfully in windbreaks. These soils provide food and cover for wildlife.

Erosion by water and soil blowing are the principal hazards. It is important that the available moisture be used efficiently. The organic-matter content needs to be increased. Terraces, grassed waterways, and contour farming help prevent water erosion. Stubble mulching and planting cover crops in the fall protect these soils from both water erosion and soil blowing during the winter and spring. Green-manure crops and crop residue help increase organic-matter content.

Irrigation management.--Corn, sorghum, alfalfa, soybeans, and tame grasses are the principal irrigated crops.

Erosion by water is the principal hazard. Proper water management and the need to increase organic-matter content are concerns. Land reshaping is needed to control water erosion. Bench leveling is suitable where the soils are gently sloping. Row crops should be grown only on the benches or on gentle slopes. Organic-matter content can be increased by returning crop residue to the soil, applying barnyard manure, and plowing under cover crops. Nitrogen and phosphorus fertilizers are needed to maintain fertility. Alfalfa and grasses in the cropping sequence control soil blowing and increase fertility.

Capability Units IVe-9 Dryland and IVe-12 Irrigated

Coly and Kenesaw silt loams, 7 to 10 percent slopes, are in these capability units. Both are deep, well-drained soils that formed on uplands in medium-textured material. The Coly soils are lighter colored than the Kenesaw soils and are calcareous at the surface.

The soils in these capability units have moderate permeability, high available water capacity, low organic-matter content, and low to medium natural fertility. They absorb moisture well and release it readily to plants. Surface runoff is rapid.

Dryland management.--Most of the acreage of these soils is in native range. When properly managed they are suited to wheat, alfalfa, and tame grasses, but not to row crops. Trees can be grown in windbreaks.

Erosion by water, rapid surface runoff, and low fertility are the main hazards where these soils are cultivated. Contour farming and terraces are needed to reduce surface runoff and control erosion. Planting cover crops and leaving crop residue on the surface are ways to increase absorption of water and to reduce soil loss by runoff. Legumes and legume-grass mixtures in the cropping sequence and return of crop residue to the soil help to increase the organic-matter content and build up fertility. Applications of commercial fertilizer, especially nitrogen, also help to increase fertility.

Irrigation management.--Alfalfa, wheat, and tame grasses are the main crops suited to irrigation. Row crops are not suited.

Erosion by water and soil blowing are hazards; and low fertility and proper control of irrigation water are concerns of management. Terraces and contour farming help to control water erosion. If water is applied at the proper rate, irrigation does not increase the erosion hazard. Planting only close-growing crops prevents soil blowing. Returning crop residue to the soil, adding barnyard manure, and using commercial fertilizers are ways of building up the content of organic matter and of improving fertility.

Capability Units IVs-1 Dryland and IIIs-1 Irrigated

These units consist of the moderately saline and alkali soils of the Leshara and Wann series. These are deep, nearly level, somewhat poorly drained soils on bottom lands. They have a medium-textured surface layer and medium to moderately coarse

textured underlying material. The water table is at depths of 2 to 6 feet, depending on the season. Permeability generally is moderate to moderately rapid. The available water capacity is high, and the organic-matter content is medium to low. Fertility is moderately high, but some plant nutrients are not readily available. Slick spots occur where the alkalinity is highest. The soil in these areas is sticky when wet, and tillage implements often become stuck. When dry, the soil in the slick spots is hard. Plants grow less well on the soils in these units than on soils not affected by salts and alkali.

Dryland management.--Corn, sorghum, and alfalfa are the most common dryfarmed crops. Tame grasses and wheat are also grown. Trees grow well. These soils provide food and cover for wildlife.

Reducing the salinity and alkalinity of these soils is the principal concern. In some small areas cultivated crops grow poorly because saline and alkali conditions are so severe that certain plant nutrients are not available. Only crops that are tolerant of high salinity and alkalinity should be planted. The soils need to be tilled only when moderately moist. Including legumes in the cropping sequence lessens the need for yearly tillage and also adds fertility. Applications of barnyard manure and plowing under green-manure crops are ways to improve tilth, increase intake of moisture, and increase content of organic matter. Nitrogen fertilizer is needed to maintain fertility. Legumes generally respond to applications of phosphate fertilizer. Use of such soil amendments as gypsum and sulfur generally produces only fair results.

Irrigation management.--Corn, sorghum, alfalfa, sugar beets, and tame grasses are the most successful irrigated crops.

Improving tilth and increasing productivity are the main concerns. Turning under crop residue and green-manure crops are ways to make these soils more friable and to increase their intake of water. Fertility can be increased by generous applications of barnyard manure and nitrogen and phosphate fertilizers. Use of soil amendments such as gypsum and sulfur generally gives only fair results. Frequent irrigation is necessary because crops cannot absorb water readily from these soils. Surface drainage can be improved by land leveling followed by annual or semiannual land smoothing.

Capability Unit IVw-2 Dryland

Scott silt loam is the only soil in this unit. It is a deep, nearly level, poorly drained soil in depressions on the uplands. The surface layer is thin and medium textured, the subsoil is thick, dense, and clayey, and the underlying material is medium textured. Tillage is difficult because the subsoil, which is near the surface, is very sticky when wet and very hard when dry. Permeability is very slow, and water that collects in the depressions during and after heavy rains remains on the surface for a long time. Although this soil has a high available water capacity, it releases moisture slowly to plants. Both the organic-matter content and natural fertility are moderate.

Corn, sorghum, small grains, and tame grasses are grown where the soil is adequately drained. Elsewhere, cultivated crops can be grown only about once in 10 years. Reed canarygrass, which is tolerant of flooding, can be grown successfully where satisfactory surface drainage cannot be established. Alfalfa is rarely planted because it is sensitive to excess surface moisture. Although this soil is not suited to trees, it provides excellent habitat for wildlife.

Flooding is a severe hazard, and poor tilth is a concern. Diversion terraces on adjacent higher land can help reduce flooding, and V-ditches can be used to remove excess surface water if an outlet is available. Turning under crop residue and barnyard manure makes the soil more friable and tillage less difficult; also, the soil releases water more readily to plants. Applications of nitrogen fertilizer are necessary for sustained production of crops.

This soil is not suited to irrigation.

Capability Units VIs-4 Dryland and IVs-4 Irrigated

Meadin silt loam, terrace, 0 to 1 percent slopes, is the only soil in these units. It is a shallow, excessively drained soil on alluvial terraces. The surface layer is medium textured, and the underlying material is coarse textured. The depth to mixed sand and gravel is between 10 and 20 inches. This soil absorbs moisture readily and has rapid permeability. It has very low available water capacity, low organic-matter content, and low natural fertility. Surface runoff is slow.

Dryland management.--This soil is too shallow and droughty for dryfarmed cultivated crops. It is best suited to grass and trees. Under good management, this soil produces fair stands of desirable grasses.

Maintenance of productivity is the main concern. Reseeding is necessary for continuous production if native grasses are not allowed to produce seed. Range practices such as deferred grazing, rotation grazing, mowing, and chemical spraying also help in maintaining productivity. Proper management is needed to control erosion and to conserve moisture.

Irrigation management.--Small grains and tame grasses are the most suitable crops. Corn, sorghum, and alfalfa are grown successfully in some places.

Improvement of fertility and proper management of water are the principal concerns. Also, during land leveling, care should be taken not to expose the underlying sand and gravel. If the cropping sequence includes alfalfa, it improves fertility and provides a ground cover. Applications of barnyard manure and a regular program of fertilization with nitrogen also help to improve fertility. Irrigation water needs to be applied frequently because the soil has

very low available water capacity. Sprinkler systems are best for irrigation. Tame grasses can be kept vigorous by rotation grazing.

Capability Units VIw-4 Dryland and IVw-4 Irrigated

These units consist of the somewhat poorly drained, nearly level to very gently sloping Platte soils and Platte-Wann complex, channeled. They occur on bottom lands. Their surface layer is medium textured to coarse textured, and the underlying material is moderately coarse textured. These soils are calcareous at the surface. They absorb water well and release it readily to plants. Their permeability is moderately rapid, their organic-matter content is low to moderate, and their natural fertility is low to medium. The depth to mixed sand and gravel ranges from 10 to 40 inches. Surface runoff is slow.

Dryland management.--These soils are too shallow and droughty for successful dryfarming. They are best suited to grasses for pasture and to trees, but they also provide habitat for wildlife.

Droughtiness during summer when the water table is lowest is the principal concern. Forage can be produced if grasses are allowed to make a good growth in spring and early in summer. Rotation and deferred grazing are proper range management practices. Some acreage is used as meadow land. Weeds and brush can be controlled by mowing and by applying chemical sprays.

Irrigation management.--Small grains and tame grasses are suitable for irrigation on these soils. Although corn and sorghum are grown in places, row crops generally are not well suited.

Fertility maintenance and control of irrigation water are the main concerns in management. Turning under crop residue increases the organic-matter content, and applications of commercial fertilizer help to maintain fertility. Land leveling is needed for efficient distribution of irrigation water by gravity. During leveling, care needs to be taken not to expose the underlying sand and gravel. Runs need to be short. Sprinkler systems are well suited for irrigating these soils.

Capability Unit VIe-5 Dryland

Valentine loamy sand is the only soil in this unit. This is a deep, nearly level to strongly sloping, excessively drained soil on complex upland landscapes. Its surface layer is coarse textured, and the underlying material is coarser with depth. This soil is loose, rapidly permeable, low in available water capacity, low in organic-matter content, and low in natural fertility. It absorbs water well and releases it readily to plants. Surface runoff is slow.

This soil is not suited to cultivation. It has an uneven, rolling topography and is too coarse, loose, and droughty. Most of the acreage is in native grass, but a small part is cultivated. Trees can be grown in windbreaks. The grass and trees provide food, cover, and nesting sites for wildlife.

Soil blowing, which results in blowouts, is a hazard. Keeping the native grasses in good vigor and managing for high production are the main concerns. The cultivated area, which is especially susceptible to soil blowing, can be planted to a mixture of native grasses that are suited to sandy soils. Blowouts also can be seeded to native grasses. Native range can be protected by using proper stocking rates and good practices of range management, such as deferred grazing and rotation grazing. Weeds and brush can be controlled by chemical sprays and mowing. Where properly managed, this soil produces a good growth of grass.

Capability Unit VIe-9 Dryland

Coly silt loam, 10 to 30 percent slopes, is the only soil in this unit. It is a deep, well-drained soil on the sides of drains and canyons. The surface layer and underlying material are medium textured and calcareous. This is the lightest colored soil in the county. It absorbs moisture readily, but most of the rainfall is lost because runoff is rapid to very rapid. This soil has moderate permeability, high available water capacity, low organic-matter content, and low natural fertility.

This soil cannot be cultivated successfully. It is too strongly sloping and erodes rapidly where the cover is removed. It is best suited to grasses and trees. It provides food, cover, and nesting sites for wildlife.

Reducing runoff and maintaining productivity are the main concerns in management. Contour grooving helps to stop some of the runoff that normally occurs, and drainageways can be dammed to create ponds for use by livestock and wildlife and for recreation. Seeding presently cultivated acreages to native grasses also would slow runoff and increase the amount of water absorbed by the soil. Where grassed areas are used for range, fencing to control cattle movement, deferred grazing, and rotation grazing help to maintain production.

Capability Unit VIs-41 Dryland

Meadin loamy sand, terrace, 0 to 2 percent slopes, is the only soil in this unit. It is shallow to mixed sand and gravel and excessively drained. It is on stream terraces in the Platte River valley. The surface layer and subsoil are coarse textured, and the underlying material is mixed sand and gravel. The rooting zone for plants is shallow. This soil has rapid permeability. It absorbs water well and releases it readily to plants. The available water capacity is very low, and the organic-matter content and natural fertility are both low. Surface runoff is slow.

This soil is too droughty to be successfully dryfarmed. It is better suited to grasses and trees than to cultivated crops. Wildlife make only limited use of this soil.

Proper management of range requires deferred grazing, rotation grazing, mowing, and other practices that allow desirable grasses to re-establish themselves. Any acreage now in cultivation can be reseeded to native grasses suited to this soil.

Capability Unit VIIe-1 Dryland

Only Rough broken land, loess, is in this unit. This land type consists of deep, medium-textured, well-drained soil material on very steep sides of canyons. The soil material has moderate permeability, high available water capacity, low organic-matter content, and low natural fertility. Moisture is absorbed readily, but most of the rainfall runs off rapidly.

This land type is suited to native grasses. Trees in shelterbelts are not well suited because the land is too steep for seedlings to be planted successfully. Wildlife use the areas for food, protection, and habitat.

Erosion by water is a hazard. Control of runoff and proper range management are the main concerns. A good cover helps to reduce surface runoff and to prevent gulley erosion. Most areas, however, are too steep for use of machinery to seed grasses. Structures for erosion control can be built in favorable locations. In some places dams can be built to create ponds for livestock and wildlife. Deferred grazing and rotation grazing are needed for maintenance of good cover and maximum production of forage.

Capability Unit VIIs-3 Dryland

Only Loamy alluvial land is in this unit. This is poorly drained, nearly level to very gently sloping soil material on bottom lands adjacent to channels of the Platte River. The surface layer is dark gray and loamy and ranges from 1 to 8 inches in thickness; it is underlain by mixed sand and gravel. Surface runoff is slow. This soil material has very rapid permeability, very low available water capacity, low organic-matter content, and low natural fertility. The depth to water ranges from 6 to 18 inches.

Loamy alluvial land has limited suitability for grazing. Native trees are common, but planting of seedling trees generally is not successful. This land provides food and cover for wildlife. Some areas are leased to hunters.

Improving range condition is the principal concern. The thinness of the surface layer and the shallow depth to water limit the kinds of plants that grow well. Deferred grazing and rotation grazing are practices that improve range condition. Proper wildlife management is needed to help preserve good hunting and fishing areas.

Capability Unit VIIIs-1 Dryland

Only Spoil banks are in this unit. They consist of disturbed silty soil material that has been stockpiled adjacent to irrigation canals, near gravel pits on bottom lands in the Platte River valley, and adjacent to roads built across depressions on the uplands. The surface features and the properties of this land type are extremely variable from place to place. The soil material along irrigation canals is mostly deep and medium textured, and its permeability is moderate. In other areas the material is too variable for accurate classification.

Most Spoil banks are covered by grasses and weeds, which provide food and cover for wildlife. Some are inhabited by fur-bearing animals, and those adjacent to water are havens for ducks. Spoil banks provide hunting areas.

Capability Unit VIIIw-1 Dryland

Only Marsh is in this unit. It occupies the wetter part of some upland depressions and a few wet areas on bottom lands in the Platte River valley. In areas of upland Marsh, the soil material is medium textured to fine textured, but in areas of bottom land Marsh, it is not so fine textured and the depth to mixed sand and gravel is 4 to 5 feet.

Marsh is very poorly drained. On the uplands, runoff from adjacent higher land covers it during most spring months and for shorter periods after heavy rain in other seasons. On bottom lands, Marsh is covered with water when the water table rises to a high level in spring but rarely at other times of the year. Areas of both upland and bottom-land Marsh are dry during periods of drought.

The vegetation consists mostly of cattails, rushes, and tall sedges. Marsh generally is too wet for cultivated crops, grasses, or trees. It provides food and habitat for wetland wildlife and affords recreation for duck hunters during open season.

Predicted Yields

The principal crops grown in Phelps County in 1964 were corn, wheat, alfalfa, sorghum, and soybeans. Data in the Nebraska Agricultural Statistics Report for 1964 indicate that about 7 percent of the corn, virtually all the wheat, 40 percent of the alfalfa, 12 percent of the sorghum, and 11 percent of the soybeans were dryfarmed: the rest of each was irrigated. The acreage of irrigated corn was a little more than 2 1/2 times the combined acreages of all other irrigated crops.

Farmers were asked to estimate the average acre yields obtained in the past several years from dryfarmed and irrigated crops on the different soils in the county. These estimates are presented in table 2. The estimates given in columns A can be expected under the management used by most farmers

TABLE 2.--PREDICTED ACRE YIELDS OF PRINCIPAL CROPS

Yields in columns A are those expected under prevailing (1970) management practices. Yields in columns B are those that can be expected under improved management. Not included in this table because they are not suited to crops are mapping units CbD, Lx, M, 2Md, RB, S, VcB]

Soil	Corn				Grain sorghum				Alfalfa				Sugar beets (Irrigated)		Soybeans (Irrigated)		Wheat (Dryland)	
	Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated							
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Tons	Tons	Bu.	Bu.	Bu.	Bu.
Anselmo fine sandy loam, 0 to 3 percent slopes-------	15	22	80	95	17	25	75	95	0.5	1.0	3.0	5.5	7	12	18	30	10	18
Anselmo fine sandy loam, hummocky------------------	12	20	50	70	12	20	50	60	.5	1.0	2.6	3.7	--	--	--	--	8	15
Anselmo fine sandy loam, hummocky, eroded----------	10	18	50	65	10	18	45	60	.4	.8	2.3	2.8	--	--	--	--	5	10
Anselmo fine sandy loam, 7 to 10 percent slopes------	10	20	40	50	10	15	35	45	.5	.9	1.5	2.5	--	--	--	--	7	14
Anselmo fine sandy loam, terrace, 0 to 3 percent slopes--------------------	19	25	90	125	20	30	80	125	1.3	2.0	3.5	6.0	10	15	22	35	15	24
Anselmo very fine sandy loam, 0 to 1 percent slopes--------------------	24	28	95	140	30	40	85	140	1.1	2.0	3.8	6.0	12	18	25	35	20	28
Anselmo very fine sandy loam, terrace, 0 to 1 percent slopes---------------	24	28	95	140	30	40	85	140	1.1	2.0	3.8	6.0	--	--	--	--	20	28
Butler silt loam------------	24	29	90	145	30	45	85	140	1.5	2.2	3.5	6.0	11	18	22	38	22	32
Butler silt loam, depressional--------------------	14	20	50	70	18	25	45	95	---	---	3.0	4.0	--	--	--	--	17	24
Cass fine sandy loam--------	19	25	85	110	20	30	75	115	1.0	1.8	3.5	6.0	10	15	22	35	15	24
Coly and Kenesaw silt loams, 7 to 10 percent slopes----	10	15	---	---	10	17	---	---	.8	1.0	2.0	3.0	--	--	--	--	5	10
Cozad silt loam------------	27	36	90	140	35	52	90	140	2.2	2.7	4.0	7.0	13	22	25	40	20	30
Crete silt loam------------	26	33	95	150	33	48	95	150	1.5	2.2	3.5	6.0	11	18	22	38	22	32
Detroit silt loam----------	26	33	95	150	33	48	95	150	1.6	2.2	3.5	6.0	11	20	22	38	20	30
Grigston silt loam---------	29	38	100	160	37	55	100	160	2.1	2.6	4.0	7.0	13	22	25	40	22	32
Hobbs silt loam------------	26	33	90	135	30	45	85	140	2.0	2.5	3.0	6.0	11	17	20	35	20	30
Hobbs silt loam, overwash---	27	36	95	145	35	52	90	145	2.2	2.7	4.0	7.0	13	22	25	40	20	30
Holdrege silt loam, 0 to 1 percent slopes------------	28	35	105	160	35	50	95	160	2.0	2.5	4.0	7.0	13	22	25	40	22	32
Holdrege silt loam, 1 to 3 percent slopes------------	20	32	95	140	30	45	90	145	1.5	2.0	3.0	6.0	11	17	20	35	20	30
Holdrege silt loam, 1 to 3 percent slopes, eroded----	18	30	95	140	28	40	80	140	1.3	1.8	2.7	5.7	10	15	18	33	18	28
Holdrege silt loam, 3 to 7 percent slopes------------	16	27	80	100	28	40	80	110	1.5	2.0	2.5	5.5	--	--	--	--	18	28
Holdrege silt loam, 3 to 7 percent slopes, eroded----	15	25	75	95	26	38	65	95	1.0	1.5	2.4	5.4	--	--	--	--	15	25
Holdrege silt loam, 7 to 10 percent slopes------------	10	20	---	---	15	25	---	---	1.3	1.8	2.0	2.5	--	--	--	--	10	20
Holdrege soils, 3 to 7 percent slopes, severely eroded--------------------	10	15	---	---	10	20	---	---	1.0	1.3	1.5	2.5	--	--	--	--	5	10
Holdrege-Coly complex, 7 to 10 percent slopes, eroded-	5	15	---	---	10	15	---	---	1.0	1.5	1.5	2.0	--	--	--	--	5	10
Hord silt loam-------------	28	35	105	160	35	50	105	160	2.0	2.5	4.0	7.0	13	22	25	40	22	35
Hord silt loam, terrace-----	28	35	105	160	35	50	105	160	2.0	2.5	4.0	7.0	13	22	25	40	22	35
Kenesaw silt loam, 0 to 1 percent slopes------------	25	30	100	140	32	45	100	145	2.0	2.5	4.0	7.0	12	18	20	35	20	30
Kenesaw silt loam, terrace, 1 to 3 percent slopes-----	20	32	90	140	30	45	90	145	1.5	2.0	3.0	6.0	11	17	20	35	20	30

TABLE 2.--PREDICTED ACRE YIELDS OF PRINCIPAL CROPS--Continued

Soil	Corn				Grain sorghum				Alfalfa				Sugar beets (Irrigated)		Soybeans (Irrigated)		Wheat (Dryland)	
	Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated							
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Tons	Tons	Bu.	Bu.	Bu.	Bu.
Kenesaw and Coly silt loams, 1 to 3 percent slopes	22	27	90	130	29	40	90	130	1.8	2.2	3.5	1.0	10	15	18	30	18	28
Kenesaw and Coly silt loams, hummocky	18	25	50	70	27	38	45	60	1.4	1.7	2.5	3.5	--	--	--	--	10	18
Kenesaw and Coly silt loams, hummocky, eroded	15	20	45	65	20	24	40	55	1.2	1.5	2.4	3.4	--	--	--	--	9	14
Leshara silt loam	21	26	75	05	26	28	70	100	2.0	2.5	3.0	5.0	10	15	18	30	16	24
Leshara silt loam, saline	17	21	35	55	21	30	35	60	1.6	2.0	2.2	3.7	8	10	14	24	13	19
Meadin silt loam, terrace, 0 to 1 percent slopes	--	--	30	50	--	--	35	55	---	---	1.3	2.5	--	--	--	--	--	--
O'Neill fine sandy loam, 0 to 1 percent slopes	17	22	80	110	18	26	70	105	.9	1.0	2.8	4.7	--	--	--	--	10	12
Platte soils	--	--	30	45	--	--	30	50	---	---	1.0	1.4	--	--	--	--	--	--
Platte-Wann complex, channeled	--	--	40	55	--	--	35	55	---	---	1.5	2.0	--	--	--	--	--	--
Rusco silt loam	18	26	50	70	27	38	50	80	1.8	3.6	3.3	5.2	9	14	16	30	16	24
Scott silt loam	8	15	---	---	10	15	---	---	---	.9	---	---	--	--	--	--	10	15
Thurman loamy fine sand, terrace, 0 to 3 percent slopes	10	20	70	90	14	22	60	85	.8	1.5	2.5	4.0	8	11	18	28	10	18
Wann fine sandy loam	16	20	70	95	20	30	62	90	1.3	1.8	2.6	4.5	8	10	16	24	13	20
Wann loam	20	25	75	100	24	36	68	100	1.9	2.4	2.8	4.7	9	14	17	28	15	23
Wann loam, saline	16	20	30	55	19	29	35	60	1.6	2.0	2.2	3.7	7	10	14	24	12	18

in the county. Yields that can be expected under improved management are given in the same table in the columns headed B.

Improved management entails the following:

1. Control of erosion by recommended conservation methods.
2. Adoption of a cropping sequence that includes some legumes and close-growing crops.
3. Application of barnyard manure, commercial fertilizer, lime, and other soil amendments in amounts indicated by soil tests; and turning under crop residue and green-manure crops.
4. Use of proper methods of tillage, seedbed preparation, and water application.
5. Selection of adapted varieties of crops and seeding at a rate that insures optimum plant density.
6. Provision for drainage as needed.
7. Control of insects, crop diseases, and weeds.
8. Timely performance of all management practices.

The predicted yields under high-level management take into account data obtained in the county, results of special studies made by the Soil Conservation Service, and opinions of specialists in related fields. Possible crop damage by hail or other unpredictable acts of nature were excluded from consideration in predicting yields. As most wheat is grown under a summer-fallow plan of management, the predicted yields of that crop are those that could be expected only in alternate years. Average acre yields for different soils should not be regarded as a measure of net income, because the cost of crop production can differ from one soil to another. For example, where crops are irrigated, the kind of irrigation system and the amount of water applied are important items of cost.

Managing the Soils for Range[3]

Rangeland amounts to about 18 percent of the farmland in Phelps County. It is widely scattered throughout the county but is somewhat concentrated in the rough land of the southwestern part and in the sandhills of the northeastern part. It is generally not suited for cultivation. The major soil associations in range are the Coly-Holdrege and Valentine-Anselmo associations.

Raising livestock, mainly cows and calves, is the second largest farm enterprise in Phelps County. Calves are retained for use as stockers and feeders.

Range Sites and Condition Classes

The kinds of grass that grow on a certain site depend on the kinds of soil. The rancher needs to know of the kinds of soil in his holdings and the plants each soil is capable of growing. Then he can manage the range to favor the growth of the best forage plants on each kind of soil.

A range site is a distinctive kind of range that produces a kind and amount of climax vegetation significantly different from that on other sites. A significant difference is one that is large enough to require different grazing use of management to maintain or improve the vegetation. Climax vegetation is the combination of plants that originally grew on a given site. The most productive combination of forage plants on a site generally is the climax vegetation.

Vegetation is altered by intensive grazing. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. Climax plants react to grazing by decreasing or increasing in number. The decreasers are the plants most heavily grazed; they therefore are the first to be injured by overgrazing. The increasers either withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. If heavy grazing continues, the increasers eventually decrease and are replaced by invaders. Invaders are plants not in the original plant community that begin growing when the decreasers and increasers have been weakened or eliminated.

Range condition is the current state of the plant community compared to the climax vegetation. The condition class is excellent if 76 to 100 percent of the plant community consists of species that compose the climax vegetation, good if 51 to 75 percent, fair if 26 to 50 percent, and poor if 0 to 25 percent. This classification is used in describing the existing plant stand in range sites in relation to the potential plant stand.

Maintenance and Improvement Practices

All rangeland needs management to maintain or improve range condition. Proper range use, deferred grazing, or a combination of rotation and deferred grazing, are needed practices, regardless of other practices used. Distribution of livestock in a pasture or range can be controlled by correctly locating fences, water supplies, and salting facilities.

Reseeding of native grasses from wild harvest or seeding with improved strains can improve range conditions. Some acreages of Coly silt loam, 10 to 30 percent slopes, and Valentine loamy sand that now are used for crops but are better suited to range also can be seeded to suitable range plants. Generally no special care other than proper management is needed to maintain forage composition.

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[3] By PETER N. JENSEN, range conservationist, Soil Conservation Service.

Descriptions of Range Sites

The 13 range sites recognized in Phelps County are described in the pages that follow. Each description contains the following information: the soil series and land types present in the site, the common characteristics of the soils, the topography, the plants composing the climax vegetation, the dominant plants when the site is in poor condition, and the annual forage production when the site is in excellent condition. The reader should not infer that all the soils in the indicated soil series are in the range site. To determine which soils of a given series are present, he should refer to the "Guide to Mapping Units," which indicates the range site for each mapping unit.

Subirrigated Range Site

This site consists of Loamy alluvial land and soils of the Leshara, Platte, and Wann series that are not affected appreciably by salinity. Although these differ in texture and depth, they all occur on bottom lands and are nearly level and moderately wet. The water table is within the root zone during the growing season. Ponding occurs only rarely. In most places the surface layer of these soils is calcareous.

At least 75 percent of the climax plant cover is big bluestem, indiangrass, switchgrass, little bluestem, prairie cordgrass, Canada wildrye, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are western wheatgrass and sedges. When this site is in poor condition, the dominant plants are Kentucky bluegrass, foxtail barley, blue verbena, cottonwoods, willows, and small amounts of western wheatgrass and sedges. Annual production is 5,000 to 6,000 pounds air-dry forage per acre when rainfall is average and the site is in excellent condition.

Saline Subirrigated Range Site

This site consists of Leshara silt loam, saline, and Wann loam, saline. Both are deep soils on bottom lands. The surface layer is medium textured, and the underlying material is medium to moderately coarse textured. The water table remains within the root zone during the growing season. Ponding occurs only rarely.

At least 75 percent of the climax plant cover is a mixture of alkali sacaton, Canada wildrye, indiangrass, switchgrass, western wheatgrass, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are inland saltgrass and sedges. When this site is in poor condition, the dominant plants are inland saltgrass, Kentucky bluegrass, annuals, and foxtail barley.

The annual production is 5,000 to 6,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Silty Overflow Range Site

Hobbs silt loam is the only soil in this site. This is a deep, medium-textured, very gently sloping to nearly level soil on bottom lands. It has a high available water capacity and a moderate infiltration rate. This site is subject to periodic overflow and to ponding of run-in water.

At least 65 percent of the climax plant cover is big bluestem, indiangrass, switchgrass, little bluestem, Canada wildrye, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are western wheatgrass, sideoats grama, and sedges. When the site is in poor range condition, the dominant plants are Kentucky bluegrass, Baldwin ironweed, western wheatgrass, and blue grama.

The annual production is 4,000 to 5,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Clayey Overflow Range Site

Butler silt loam, depressional, is the only soil in this site. This is a deep, nearly level soil in depressions on the upland. It has a medium-textured surface layer and a fine-textured claypan subsoil. This soil has slow permeability and is subject to ponding by runoff from adjacent higher land.

About 50 percent of the climax plant cover is big bluestem, Canada wildrye, indiangrass, little bluestem, switchgrass, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, buffalograss, western wheatgrass, and sedges. When this site is in poor range condition, the dominant plants are western ragweed, Kentucky bluegrass, Baldwin ironweed, western wheatgrass, blue grama, and buffalograss.

The annual production is 2,500 to 4,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Sandy Lowland Range Site

Cass fine sandy loam, the only soil in this site, is a deep, well-drained, nearly level soil on bottom lands. Both the surface layer and underlying material are moderately coarse textured. The depth to the water table ranges from 5 to 10 feet.

At least 70 percent of the climax plant cover is sand bluestem, indiangrass, switchgrass, little bluestem, needle-and-thread, Canada wildrye, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are prairie sandreed, blue grama, sand dropseed, western wheatgrass, and sedges. When this site is in poor range condition, the dominant plants are sand dropseed, blue grama, and western ragweed.

The annual production is 3,000 to 4,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Silty Lowland Range Site

This site consists of soils of the Cozad, Grigston, and Rusco series, Hobbs silt loam, overwash, and the terrace phases of Hord and Kenesaw silt loams. These are well-drained, nearly level to very gently sloping soils on bottom lands and terraces. The surface layer is medium textured, and the subsoil and underlying material are medium textured to moderately fine textured. These soils have a high available water capacity and a moderate infiltration rate. Occasional run-in water provides additional moisture for vegetation.

At least 70 percent of the climax plant cover is big bluestem, indiangrass, little bluestem, switchgrass, needle-and-thread, Canada wildrye, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, sand dropseed, side-oats grama, and western wheatgrass. When this site is in poor range condition, the dominant plants are Kentucky bluegrass, western wheatgrass, blue grama, Baldwin ironweed, and western ragweed.

The annual production is 3,000 to 4,500 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Sands Range Site

Valentine loamy sand is the only soil in this site. This is a deep, very gently undulating to rolling, coarse-textured soil on the uplands. It has low available water capacity.

At least 60 percent of the climax plant cover is sand bluestem, switchgrass, indiangrass, sand lovegrass, prairie junegrass, Canada wildrye, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, little bluestem, needle-and-thread, prairie sandreed, sand dropseed, and sedges. When the site is in poor range condition, the dominant plants are sand dropseed, blue grama, western ragweed, and annuals.

The annual production is 2,000 to 3,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Sandy Range Site

This site consists of soils of the Anselmo, O'Neill, and Thurman series. These are moderately deep to deep, nearly level to moderately sloping soils on the uplands and on terraces. The surface layer of these soils ranges from very fine sandy loam to loamy fine sand, and the underlying material ranges from fine sandy loam to fine sand. These soils are well drained to somewhat excessively drained, and they have a moderately rapid infiltration rate.

At least 65 percent of the climax plant cover is sand bluestem, little bluestem, indiangrass, switchgrass, needle-and-thread, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are prairie sandreed, blue grama, sand dropseed, and western wheatgrass. When the site is in poor range condition, the dominant plants are blue grama, sand dropseed, sand paspalum, western wheatgrass, windmillgrass, and tumblegrass.

The annual production is 2,000 to 3,000 pounds of air-dry forage per acre when rainfall is average and the site is in excellent condition.

Silty Range Site

This site consists of soil in the Detroit and Holdrege series and those Hord and Kenesaw soils that are on uplands. The soils of this site are nearly level to moderately sloping and well drained. They have a medium-textured surface layer, a medium to moderately fine textured subsoil, and medium-textured underlying material. These soils have high available water capacity and moderate to moderately slow infiltration rate.

At least 55 percent of the climax plant cover is big bluestem, little bluestem, indiangrass, switchgrass, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, buffalograss, side-oats grama, and western wheatgrass. When the site is in poor range condition, the dominant plants are blue grama, buffalograss, western ragweed, blue verbena, and plains pricklypear.

The annual production is 2,500 to 3,500 pounds of air-dry forage per acre when rainfall is average and the site is in excellent condition.

Clayey Range Site

This site consists of Butler silt loam and Crete silt loam. These are deep, nearly level, moderately well drained to somewhat poorly drained soils. They have a medium-textured surface layer and a fine-textured subsoil. The clayey subsoil has slow permeability.

At least 45 percent of the climax plant cover is big bluestem, Canada wildrye, indiangrass, little bluestem, switchgrass, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, buffalograss, tall dropseed, and western wheatgrass. When the site is in poor range condition, the dominant plants are buffalograss, blue grama, blue verbena, western wheatgrass, and cool-season annual grasses.

The annual production is 2,500 to 3,500 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Limy Upland Range Site

This site consists of soils of the Coly series. These are moderately sloping to steep, well-drained calcareous soils on the uplands. The surface layer

and the underlying material are medium textured. These soils have moderate available water capacity.

At least 60 percent of the climax plant cover is big bluestem, little bluestem, switchgrass, indiangrass, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, buffalograss, and sideoats grama. When the site is in poor range condition, the dominant plants are blue grama, buffalograss, western ragweed, blue verbena, and plains pricklypear.

The annual production is 1,500 to 3,000 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Shallow to Gravel Range Site

This site consists of soils of the Meadin series These shallow soils are on stream terraces and have a medium-textured to coarse-textured surface layer and coarse-textured underlying material. The depth to mixed sand and gravel ranges from 10 to 20 inches. These soils have a very low available water capacity.

At least 60 percent of the climax plant cover is big bluestem, sand bluestem, little bluestem, sideoats grama, prairie sandreed, and other decreaser grasses. The rest is perennial grasses and forbs. The principal increasers are blue grama, sand dropseed, western wheatgrass, and sedges. When the site is in poor range condition, the dominant plants are blue grama, sand dropseed, broom snakeweed, and plains pricklypear.

The annual production is 1,500 to 2,500 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Thin Loess Range Site

Rough broken land, loess, is the only mapping unit in this site. This very steep, medium-textured, calcareous soil material is on the uplands. Catsteps and landslips are common. Surface runoff is excessive.

At least 65 percent of the climax plant cover is little bluestem, big bluestem, side-oats grama, switchgrass, plains muhly, and other decreaser grasses. The rest is other perennial grasses and forbs. The principal increasers are blue grama, sand dropseed, and western wheatgrass. When the site is in poor range condition, the dominant plants are blue grama, sand dropseed, broom snakeweed, and various annuals.

The annual production is 1,500 to 2,500 pounds per acre of air-dry forage when rainfall is average and the site is in excellent condition.

Managing the Soils for Woodland and Windbreaks [4/]

Several kinds of trees and shrubs are native to Phelps County. These grow on bottom lands where water is continuously available at shallow depth or in protected places where water tends to collect and persist. Some introduced trees have invaded the stands of native woodland. Many windbreaks that combined rows of trees and shrubs have been established on the uplands and terraces as well as on bottom lands.

Native Woodland

Most of the native woodland in Phelps County is along the Platte River and its larger tributaries. Much of the rest is in the valleys of Plum, Spring, and Elm Creeks.

Timbered areas along the Platte River are rather extensive. They include many trees of considerable size and consist mostly of cottonwood. Other trees in these stands are boxelder, green ash, American elm, eastern redcedar, and Russian-olive. Russian-olive is not indigenous to the area but has spread from windbreak plantings into the stands of native trees. It is becoming a serious pest. Several species of willow grow along the river banks and on sandbars in the river.

American elm and green ash are the most common trees in timbered areas along the tributaries of the Platte River. Some boxelder, hackberry, walnut, and other wetland species are in these stands. Native shrubs grow in scattered patches throughout the county, generally in the more protected sites. The most common of these are coralberry and American plum.

The stands of native trees have little economic value at present, although the volume of cottonwood is enough to justify harvesting if a market were nearby. Trees along the streams add to the beauty of the area and provide cover for several kinds of wildlife, thereby contributing to the recreational potential of the county.

Windbreaks

Early settlers in Phelps County began the practice of planting trees around farmsteads and ranch headquarters. Some of these trees still survive, though the houses and outbuildings may have disappeared. The planting of trees, generally for windbreaks, continues today. The effectiveness of windbreaks depends on the kinds of trees selected, the method and pattern of planting, the kind of soil, and the care provided after the trees are planted. Specific information on the design,

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4/ By GEORGE W. ALLEY and JAMES W. CARR, woodland conservationists, Soil Conservation Service.

establishment, and maintenance of windbreaks is available from the Soil Conservation Service and from local representatives of the Agricultural Extension Service.

Windbreaks are planted for different purposes. Farmstead and ranch windbreaks (pl. IV, top) serve as wind barriers for buildings, feedlots, driveways, gardens, and other areas important to the operation of the farm or ranch. They also contribute to human comfort, reduce heating bills, save livestock feed, and control drifting of snow. Livestock-protection windbreaks generally are on rangeland that is well removed from buildings. They are planted along the windward borders of wintering and calving areas and of other areas where livestock congregate. Field windbreaks are planted on cropland to help prevent soil blowing and crop damage. They are especially important where sandy soils are used for cultivated crops.

The medium-textured Holdrege, Kenesaw, and Coly soils, which together constitute 80 percent of the county area, support good tree growth if the planting sites are prepared and maintained properly. If the site selected for a windbreak is in grass or alfalfa, it should be summer fallowed prior to planting the trees and cultivated after planting. Sandy soils, such as Valentine and Thurman, require special planting methods and care because soil blowing is a hazard.

Growth of Trees in Windbreaks

The rate of tree growth in a windbreak depends upon the soil and kinds of trees planted. Fertility, available moisture, and direction and steepness of slope are soil properties that affect the growth rate. Spacing and arrangement of species within the windbreak also are important factors.

Many considerations are necessary when choosing trees for planting in windbreaks. Some kinds of trees, especially cottonwood, grow fast but tend to die young. Siberian elm and Russian-olive also grow rapidly and often are shortlived; furthermore, they are likely to spread where not wanted. Boxelder freezes back in severe winters, and green ash is subject to borers. Ponderosa and other pines, eastern redcedar, Rocky Mountain juniper, hackberry, and honeylocust are high in survival and vigor compared to other kinds of trees. Cedar and juniper generally grow a little less than a foot per year and reach a height of from 15 to 25 feet, depending on the soil properties. Pines and deciduous trees grow faster and generally are taller at maturity. Table 3 gives the relative vigor and average height at 20 years for several kinds of trees that commonly are planted on soils of the principal windbreak suitability groups.

Windbreak Suitability Groups

The soils of Phelps County are grouped according to their suitability for windbreaks. Soils in any one group produce similar growth and survival under normal weather conditions and with proper care. The soil series represented in a windbreak suitability group are given in the description of the group, but the reader should not assume that all the soils of the indicated series are necessarily among the soils that make up the group. To find the names of all the soils in any given group, reference should be made to the "Guide to Mapping Units" at the back of the survey. Each of the following descriptions of

TABLE 3.--RELATIVE VIGOR OF TREES GROWN IN WINDBREAKS AND ESTIMATED AVERAGE HEIGHT ATTAINED IN 20 YEARS[1/]

Kind of tree	Windbreak suitability group									
	Silty to clayey		Sandy		Very sandy		Moderately wet		Shallow	
	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height
		Feet		Feet		Feet		Feet		Feet
Eastern redcedar.	Excellent-	17	Excellent	18	Excellent-	15	Excellent-	17	Excellent-	15
Ponderosa pine.	Excellent-	21	Excellent-	21	Excellent-	26	Unsuited-	(2/)	Excellent-	20
Green ash---	Good------	22	Good------	23	Unsuited--	(2/)	(3/)------	(3/)	Unsuited--	(2/)
Hackberry---	Good------	19	Good------	20	Unsuited--	(2/)	(3/)------	(3/)	Unsuited--	(2/)
Honeylocust-	Good------	24	Good------	22	Unsuited--	(2/)	(3/)------	(3/)	Unsuited--	(2/)
Cottonwood--	Unsuited--	(2/)	Fair to good.	53	Unsuited--	(2/)	Good------	58	Unsuited--	(2/)
Russian-olive.	Poor------	15	(3/)------	(3/)	Unsuited--	(2/)	Unsuited--	(2/)	Unsuited--	(2/)

1/ Very Wet, Moderately Saline-alkali, and Undesirable suitability groups are not included because the need for windbreaks on these soils in Phelps County is uncommon.

2/ Not applicable.

3/ Insufficient data available.

windbreak suitability groups names the trees and shrubs that are suited to planting.

Silty to Clayey Windbreak Suitability Group

This unit consists of soils of the Anselmo, Butler, Coly, Cozad, Crete, Detroit, Grigston, Hobbs, Holdrege, Hord, and Kenesaw series. These soils are on bottom lands, stream terraces, and uplands. All are deep and have a medium-textured surface layer that is underlain by fine textured to moderately coarse textured material. Except for the somewhat poorly drained Butler soils and the moderately well drained Crete soils, all are well drained. The available water capacity of the Anselmo and Cass soils is moderate, and that of all the others is high.

Windbreaks have a good chance for survival and growth if not subjected to severe drought or excessive competition with grasses or weeds for the available moisture. Erosion by water is a hazard where windbreaks are planted on sloping soils.

Conifers suitable for windbreaks are eastern redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, and Scotch pine. Suitability deciduous trees are green ash, hackberry, honeylocust, and bur oak; suitable shrubs are cotoneaster, honeysuckle, lilac, chokecherry, and American plum.

Sandy Windbreak Suitability Group

Soils of the Anselmo, Cass, O'Neill, and Thurman series make up this group. These are deep and moderately deep, well drained to somewhat excessively drained, nearly level to moderately sloping soils on bottom lands, stream terraces, and uplands. They have a moderately coarse textured surface layer, subsoil, and underlying material and moderately rapid to rapid permeability. Available water capacity is low to moderate.

Windbreaks have a good chance for survival and growth if not subjected to drought or competition with grasses and weeds for the available moisture. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the tree rows. Erosion by water can be a hazard where trees are planted in gently to moderately sloping areas.

Conifers suitable for windbreaks are eastern redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, and Scotch pine. Suitable deciduous trees are green ash, honeylocust, and Russian mulberry; suitable shrubs are honeysuckle, cotoneaster, lilac, skunkbush sumac, and American plum.

Very Sandy Windbreak Suitability Group

Valentine loamy sand is the only soil in this group. It is a deep, excessively drained soil on the uplands. Both the surface layer and underlying material are coarse textured. This soil has weak structure and is mildly alkaline. The available water capacity is low.

Only windbreaks consisting of conifers have a good chance for survival and growth. Because this soil is so loose, trees need to be planted in shallow furrows and not cultivated after planting. Soil blowing is a hazard. During high winds, young seedlings may be covered by drifting sand.

Conifers suitable for windbreaks are eastern recedar, ponderosa pine, Rocky Mountain juniper, Austrian pine, and Scotch pine.

Moderately Wet Windbreak Suitability Group

This group consists of soils of the Butler, Hobbs, Leshara, Platte, Rusco, and Wann series. Most soils in this group are on bottom lands, but some are in depressions on the uplands. These soils have a fine textured to moderately coarse textured surface layer and fine textured to very coarse textured underlying material. They are moderately wet, some from occasional flooding and some because the depth to water is only 2 to 6 feet. The available water capacity ranges from low to high.

Windbreaks have a good chance for survival and growth if the trees are species that tolerate occasional wetness. Establishment of trees can be difficult in wet years. The abundant and persistent herbaceous vegetation competes with the young trees and also makes it difficult to cultivate between the rows.

Conifers suitable for windbreaks are eastern redcedar and Austrian pine. Suitable deciduous trees are honeylocust, green ash, white willow, and cottonwood; suitable shrubs are chokecherry, American plum, red-osier dogwood, and buffaloberry.

Shallow Windbreak Suitability Group

The two soils of the Meadin series make up this group. These soils are on stream terraces, have a medium-textured to coarse-textured surface layer, and are only 10 to 20 inches thick over mixed sand and gravel. They are excessively drained and have a very low available water capacity.

Windbreaks are limited by the shallow rooting zone and by the lack of moisture. Trees planted on these soils are damaged by drought during most years.

The only tree suitable for windbreaks is eastern redcedar.

Moderately Saline-Alkali Windbreak Suitability Group

Soils of the Leshara and Wann series make up this group. These deep soils are on bottom lands and are moderately affected by salts and alkali. They have a medium-textured surface layer and medium textured to moderately coarse textured underlying material. The depth to water ranges from 2 to 6 feet, and the available water capacity is moderate to high.

Trees for windbreaks are limited to those species that are tolerant of moderate concentrations of salts or alkali. Establishment of trees can be difficult in wet years. Wetness can be a hazard to cultivation between the tree rows.

Conifers suitable for windbreaks are eastern redcedar, Rocky Mountain juniper, and Austrian pine. Suitable deciduous trees are green ash, honeylocust, cottonwood, and Russian-olive; suitable shrubs are buffaloberry and skunkbush sumac.

Undesirable Windbreak Suitability Group

This group consists of soils in the Scott series and Loamy alluvial land, Marsh, Spoil banks, and Rough broken land, loess. These soils and land types occur on bottom lands, stream terraces, and uplands, and they have a wide range of soil textures and characteristics.

The soil materials of this group generally are not suited to windbreaks. They are too steep, wet, or shallow, or are so nearly inaccessible, that it is not feasible to establish a windbreak. In places a few trees or shrubs can be grown successfully if they are carefully planted and attended.

Managing the Soils for Wildlife and Recreation [5/]

The kinds and amount of wildlife that can be produced and maintained in an area are determined largely by the kinds, amount, and distribution of vegetation. These, in turn, are governed by soil characteristics such as slope, fertility, and capacity to absorb, hold, and release moisture.

The soils of Phelps County are capable of producing food and cover for many birds and animals. Before the county was settled, it provided suitable habitat for elk, buffalo, wolves, and many kinds of birds and small furbearing animals. Now that the soils are used mostly for crops and range, only the extremely rough land, the swampy land, and the land occupied by stands of native trees still provide relatively unaltered wildlife habitat.

Furbearing animals inhabiting the county are raccoon, opossum, weasel, mink, muskrat, coyote, skunk, and deer. Birds are numerous, and those requiring a woody habitat are found in the native woodlands along streams and in windbreaks, around farmsteads and livestock areas. Wild turkey have been reintroduced into the area, but pheasant, bobwhite quail, and waterfowl are the most important game birds. Birds are especially important for the control of insects, and other kinds of wildlife help to control damage by undesirable rodents. The most important kind of fish in the Platte River is channel catfish.

Although the established windbreaks provide some food and cover for birds and small furbearing animals, more could be done to improve the habitat for desirable wildlife. Thin stands of vegetation on the extremely rough areas generally can be improved through proper management. Some of the wetlands can be made more productive of wildlife through maintenance of the water level at the optimum stage. Ponds for fish production can be excavated into soils where the water table is close to the surface, and where a sufficient water supply is available. Ponds also can be constructed in soils that have a low seepage rate. Water draining from fertile soils is generally rich in plant nutrients, and where it collects in ponds or runs off into streams it supports aquatic vegetation that is necessary for the sustenance of fish and other aquatic and semiaquatic life.

Some kinds of wildlife are important for the recreational opportunities they provide. Hunting and fishing are the principal recreational pursuits in the county, but some people also enjoy hearing, seeing, and photographing wildlife. The soils and topography of Phelps County are suited to the further development of recreational enterprises. Some of these enterprises can be incorporated into farm and ranch operations and can be especially valuable to owners whose means are limited by the size of their farms or ranches. Increased travel by the American public provides opportunities to develop overnight camping facilities along main highways through the county. Such facilities are a convenience to travelers and can be an additional source of income to landowners.

Where the production of wildlife is proposed for recreational purposes, the types of soils and their characteristics are important considerations. In table 4 the soil associations are rated very good, good, fair, or poor with respect to their potential for producing the various kinds of vegetation needed by wildlife. For descriptions of the associations and their locations, reference should be made to the section "General Soil Map" in this survey. More detailed information on the kinds of vegetation that can be produced is given in the sections "Descriptions of the Soils" and "Use and Management of the Soils."

Woody plants, herbaceous plants, and grain and seed crops differ in importance as sources of food and cover for the principal kinds of game in the area. Woody plants provide both food and cover for deer. They also provide good cover for pheasant and bobwhite quail but are a source of relatively little food for these game birds. Herbaceous plants are a good source of food for mule deer and game birds but are only a moderately good source of food for white-tailed deer. Generally only game birds are afforded good cover by this type of vegetation. Grain and seed crops are excellent sources of food for all types of game, but they afford good cover only for pheasant. Such crops on the Leshara and Wann soils are important sources of food for migratory ducks and geese.

[5/] By C. V. BOHART, biologist, Soil Conservation Service.

TABLE 4.--POTENTIAL OF SOIL ASSOCIATIONS FOR PRODUCING WILDLIFE HABITAT

Soil association	Potential for producing--		
	Woody plants	Herbaceous plants	Grain and seed crops
Holdrege	Very good	Very good	Good to very good.
Coly-Holdrege	Very good	Very good	Good to very good.
Kenesaw-Anselmo	Very good	Very good	Good.
Valentine-Anselmo	Very good	Very good to fair	Good to poor.
Meadin-Anselmo-O'Neill	Very good to fair	Very good to fair	Good to poor.
Hord	Very good	Very good	Very good.
Leshara-Wann 1/	Very good	Very good	Very good.

1/ This soil association also has a good potential for producing aquatic habitat.

Technical assistance in planning specific habitat for wildlife developments, including the proper location and the kinds of vegetation required, can be obtained from the Soil Conservation Service. Additional information and assistance can be obtained from the Agricultural Extension Service and from the Nebraska Game and Parks Commission, Bureau of Sport Fisheries and Wildlife.

Engineering Uses of the Soils 6/

Some soil properties are of special interest to engineers because they affect the construction and maintenance of highways and roads, airports, pipelines, building foundations, facilities for storing water and controlling erosion, and systems for irrigating and draining soils and for disposing of sewage. Among the properties most important to engineers are soil texture, permeability, shear strength, plasticity, reaction, compaction characteristics, and available water capacity. Also important are topography, depth to the water table, and depth to bedrock or to sand and gravel. Information concerning these and related soil properties is given in tables 5, 6, and 7. The estimates and interpretations in these tables can be used to--

1. Make studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas;
2. Make estimates of engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, waterways, and other structures for conserving soil and water;
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning more detailed investigations at selected locations;
4. Estimate the size of drainage areas and the speed and amount of runoff in designing culverts and bridges;
5. Identify the soils along proposed routes for highways for use in making preliminary estimates of the thickness required for flexible pavements;
6. Estimate the amount of clay needed to stabilize the surface of unpaved roads;
7. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing subbase courses, base courses, and surface courses of flexible pavements;
8. Make preliminary evaluations of the relief, surface drainage, subsurface drainage, depth to the water table, and other features that affect the design of highway embankments, subgrades, and pavements;
9. Correlate performance of engineering structures with soil mapping units and thus develop information that can be used in designing and maintaining these structures;
10. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment;
11. Supplement information from other published maps and surveys for the purpose of making maps and reports that can be used readily by engineers; and
12. Develop other preliminary estimates for construction purposes pertinent to the particular area.

6/ By F. STEWART BOHRER, area engineer, and GILBERT A. BOWMAN, soil scientist, Soil Conservation Service, with the assistance of ROBERT J. FREDRICKSON, civil engineer, Soil Conservation Service, and WILLIAM J. RAMSEY, Division of Materials and Tests, Nebraska Department of Roads.

The engineering interpretations in this survey, used with the soil map, serve many useful purposes. It should be emphasized, however, that they do not eliminate the need for detailed field investigations at the site of specific engineering works. Sampling and testing are particularly important where construction involves heavy loads or excavations deeper than the depths reported, generally about 5 feet. In such situations, the soilap is useful in planning further investigations and in indicating the kinds of problems that can be expected. Soils of Phelps County are deep enough that bedrock does not affect their use.

Some of the terms used by soil scientists may be unfamiliar to engineers, and some words--for example, clay, sand, and silt--may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary.

Engineering Classification Systems

The two systems most commonly used in classifying soils for engineering are the American Association of State Highway Officials system (AASHO) (1) and the Unified soil classification system (USCS) (7). The latter was developed by the U.S. Army Corps of Engineers, U.S. Department of Defense, and is also used by the Soil Conservation Service, the Bureau of Reclamation, and other organizations. Estimated classifications of all the soils in Phelps County according to both systems and according to the textural classification used by the U.S. Department of Agriculture (USDA) (3) are given in table 6.

Classification in the AASHO system is based on field performance and on gradation, liquid limit, and plastic index. In this system soil materials are placed in seven groups, ranging from A-1 through A-7. Soils in the A-1 group are gravelly and have high bearing capacity; those in the A-7 group are clayey and have low bearing capacity when wet. The relative engineering values of the soils within each group are indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index of a soil can be established only by laboratory tests. It is shown in parentheses after the soil group (see table 5).

The Unified system is based on the texture and plasticity of the soils, as well as on their performance as engineering construction material. Each classification consists of two letters that represent the principal characteristics of the soil. The first letter indicates whether the soil is coarse grained, fine grained, or organic (or peat). The coarse-grained soils are gravel, G, and sand, S. These are further classified primarily by gradation: W for well graded or P for poorly graded. For example, SP is a sand, poorly graded. The fine-grained soils are silt, M, and clay, C. These are further classified according to plasticity characteristics: L for low liquid limit and H for high liquid limit; therefore, CL is a clay of low plasticity. Organic soils, O, and peat, Pt, are classified according to odor and to plasticity changes after oven-drying. Soils that have borderline characteristics of two classifications are given a dual classification. Tables 5 and 6 show that the soils of Phelps County are classified as SP, SP-SM, SM, ML, ML-CL, and CH. Organic (OL and OH) and peat (Pt) soils are uncommon in Nebraska.

Many soil scientists use the USDA textural classification. In this system, the texture of soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay. Textural modifiers, such as gravelly, stony, shaly, and cobbly, are used as needed.

Engineering Test Data

Table 5 shows engineering test data for samples from 7 soils that were collected and tested by the Division of Materials and Tests, Nebraska Department of Roads, according to standard AASHO procedures Each soil was sampled at only one location, and the data given for the soil are those for that location. From one location to another, a soil can differ considerably in characteristics that affect engineering. Even when the soils are sampled at more than one location, the test data probably do not show the entire range in characteristics.

Moisture-density data in table 5 are the results obtained from mechanical compaction. If soil material is compacted at successively higher moisture content, and the compaction effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. Thereafter the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is the maximum dry density. Moisture-density data are important in earthwork because, as a rule, soil is most stable if it is compacted to the maximum dry density when it is at the optimum moisture content.

The engineering classifications in the last two columns of table 5 are based on data obtained by mechanical analysis and on tests to determine the liquid and plastic limits. Mechanical analyses were made by a combination of the sieve and hydrometer methods.

Tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a solid to a plastic state and from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percentage of the oven-dry weight, at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates a range of moisture content within which a soil material is in a plastic condition. Some silty and

[Tests performed by the Nebraska Department of Roads in cooperation with U.S. Department of Commerce, Bureau of Public

Soil name and location	Parent material	Nebraska report No. S62	Depth	Moisture density 1/	
				Maximum dry density	Optimum moisture
			Inches	Lb. per cu. ft.	Percent
Butler silt loam: 2,445 feet N. and 600 feet E. of SW. corner of sec. 24, T. 6 N., R. 20 W. (Modal).	Peoria loess.	150	0-6	96	22
		151	11-25	97	24
		152	66-72	100	22
Holdrege silt loam: 2,440 feet W. and 500 feet N. of SE. corner of sec. 16, T. 5 N., R. 18 W. (Maximal development).	Peoria loess.	153	5-14	98	21
		154	20-34	101	20
		155	53-72	104	20
Hord silt loam: 0.25 mile E. and 250 feet S. of NW. corner of sec. 29, T. 8 N., R. 19 W. (Modal)	Alluvium (loesslike stratified silt).	159	7-14	99	21
		160	17-22	101	21
		161	39-72	106	18
Kenesaw silt loam: 0.1 mile E. and 150 feet N. of SW. corner of sec. 13, T. 7 N., R. 18 W. (Modal).	Recent loess.	165	0-5	102	18
		166	7-20	101	22
		167	36-72	105	19
Leshara silt loam: 300 feet N. and 75 feet W. of SE. corner of sec. 11, T. 8 N., R. 20 W. (Modal).	Alluvium.	168	10-18	100	21
		169	18-26	111	14
		170	26-35	112	15
Valentine loamy sand: 2,410 feet E. and 150 feet N. of SW. corner of sec. 25, T. 8 N., R. 18 W. (Modal).	Eolian sand.	171	4-10	107	13
		172	10-26	108	12
		173	26-72	110	12
Wann loam: 0.27 mile E. and 365 feet N. of SW. corner of sec. 18, T. 8 N., R. 18 W. (Modal).	Alluvium.	174	0-5	112	14
		175	9-16	108	16
		176	16-44	106	17

1/ Based on AASHO Designation T 99-47, Method A (1).

2/ Mechanical analyses according to the American Association of State Highway Officials Designation T 88-47 (1). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

TEST DATA

Roads (BPR) in accordance with standard procèdures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis 2/							Liquid limit	Plasticity index	Classification	
Percentage passing sieve--			Percentage smaller than--							
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO 3/	Unified 4/
							Percent			
---	100	99	81	46	26	20	35	11	A-6(8)	ML-CL
---	100	99	88	66	49	44	60	33	A-7-6(20)	CH
---	100	98	80	51	28	18	39	17	A-6(11)	CL
---	100	99	82	49	28	22	40	18	A-6(11)	CL
---	100	99	87	56	34	25	44	23	A-7-6(14)	CL
---	100	99	86	44	25	20	35	14	A-6(10)	CL
---	100	93	83	41	25	21	38	16	A-6(10)	CL
---	100	94	80	43	29	24	41	20	A-7-6(12)	CL
---	100	96	82	34	18	12	32	10	A-4(8)	ML-CL
---	100	99	62	36	24	20	31	7	A-4(8)	ML-CL
---	100	99	71	41	27	20	36	13	A-6(9)	ML-CL
---	100	99	75	33	16	11	30	6	A-4(8)	ML-CL
100	98	84	63	33	20	15	38	16	A-6(10)	CL
100	92	59	34	22	15	12	28	9	A-4(5)	CL
100	95	60	32	23	18	15	26	8	A-4(5)	ML-CL
100	98	13	8	4	3	2	(5/)	(5/)	A-2-4(0)	SM
100	99	13	7	5	4	4	(5/)	(5/)	A-2-4(0)	SM
100	94	10	6	4	4	4	(5/)	(5/)	A-3(0)	SP-SM
100	99	54	27	15	11	9	22	1	A-4(4)	ML
100	99	77	53	25	18	16	28	6	A-4(8)	ML-CL
---	100	90	57	17	13	11	27	1	A-4(8)	ML

3/ Based on M 145-49 (1).

4/ Based on MIL-STD-619B (7/). SCS and BPR have agreed that all soils having plasticity indexes within 2 points of A-line are to be given a borderline classification, such as ML-CL.

5/ Nonplastic.

TABLE 6.--ESTIMATED SOIL PROPERTIES

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of is necessary to follow carefully the instructions for referring to other series that appear in the first and Wann (2Wm) are too variable to be estimated. The symbol > means more than. The symbol < means less than.]

Soil series and map symbols	Depth to seasonal high water table	Depth to sand or mixed sand and gravel	Depth from surface of typical profile	Classification 1/		
				USDA	Unified	AASHO
	Feet	Feet	Inches			
Anselmo: AnA, AnB, AnB2, AnC, 2AnA--	(4/)	4-20	0-8	Fine sandy loam--	SM or ML	A-2 or A-4
			8-30	Fine sandy loam--	SM	A-2
			30-60	Loamy sand-------	SP-SM or SM	A-2
Ag, 2Ag--------------------	8-15	5-8	0-8	Very fine sandy loam.	ML	A-4
			8-30	Fine sandy loam--	SM	A-4 or A-2
			30-60	Loamy fine sand--	SM	A-2
Butler: Bu, 2Bu-------------	(4/)	(5/)	0-14	Silt loam--------	ML or CL	A-4 or A-6
			14-28	Silty clay-------	CH	A-7
			28-36	Silty clay loam--	CL	A-6 or A-7
			36-60	Silt loam--------	CL	A-6 or A-7
Cass: Cs--------------------	5-10	3-6	0-19	Fine sandy loam--	SM	A-2 or A-4
			19-48	Sandy loam-------	SM or ML	A-4
			48-60	Loamy fine sand--	SM	A-2 or A-4
*Coly: CbD, CKC-------------- For Kenesaw part of CKC, see Kenesaw series.	(4/)	(5/)	0-8	Silt loam--------	ML or CL	A-4 or A-6
			8-60	Silt loam--------	ML or CL	A-4 or A-6
Cozad: Coz------------------	6-10	5-15	0-7	Silt loam--------	ML	A-4
			7-21	Silt loam--------	ML	A-4
			21-60	Silt loam--------	ML or CL	A-4
Crete: Ce-------------------	(4/)	(5/)	0-16	Silt loam--------	ML or CL	A-6
			16-42	Silty clay loam to silty clay.	CH or CL	A-7
			42-60	Silt loam--------	CL	A-6 or A-7
Detroit: De-----------------	(4/)	(5/)	0-12	Silt loam--------	ML or CL	A-6
			12-38	Heavy silty clay loam.	CL or CH	A-6 or A-7
			38-60	Silt loam--------	CL	A-6
Grigston: Gp----------------	4-12	4-6	0-19	Silt loam--------	ML or CL	A-4 or A-6
			19-32	Light silty clay loam.	CL	A-6
			32-60	Silt loam--------	CL	A-6
Hobbs: Hb, 2Hb--------------	(4/)	(5/)	0-30	Silt loam--------	ML or CL	A-4 or A-6
			30-40	Silt loam--------	CL	A-6
			40-60	Silt loam--------	ML or CL	A-4 or A-6

See footnotes at end of table.

soil. The soils in such mapping units may have different properties and limitations, and for this reason it column of this table. Most properties of Leshara (2Le), Loamy alluvial land (Lx), Marsh (M), Spoil banks (S),

Percentage passing sieve 2/-- No. 4	No. 10	No. 40	No. 200	Percentage finer than 0.002 mm.	Permeability	Available water capacity 3/	Shrink-swell potential
					Inches per hour	Inches per inch of soil	
-----	100	90-100	40-75	5-20	2.00-6.30	0.16-0.18	Low or moderate.
-----	100	90-98	30-49	5-20	2.00-6.30	0.15-0.17	Low.
-----	100	90-95	10-35	5-12	6.30-20.0	0.08-0.10	Low.
100	95-100	90-100	60-70	5-20	0.63-2.00	0.20-0.22	Low.
100	90-100	90-98	30-49	5-20	2.00-6.30	0.15-0.17	Low.
100	98-99	90-95	10-35	0-10	6.30-20.0	0.08-0.10	None.
-----	------	100	75-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	-----	100	90-100	40-60	0.06-0.20	0.11-0.13	High.
-----	-----	100	75-100	27-40	0.20-0.63	0.18-0.20	Moderate.
-----	-----	100	90-100	15-27	0.63-2.00	0.20-0.22	Moderate.
100	100	95-100	30-49	5-20	2.00-6.30	0.16-0.18	Low.
100	100	95-100	40-65	5-10	2.00-6.30	0.12-0.14	Low.
100	90-100	90-95	10-45	0-10	6.30-20.0	0.08-0.10	Low.
-----	100	95-100	75-100	15-27	0.63-2.00	0.22-0.24	Low to moderate.
-----	100	95-100	70-100	15-27	0.63-2.00	0.20-0.22	Low to moderate.
100	95-100	90-100	60-70	5-20	0.63-2.00	0.20-0.22	Low.
100	95-100	90-98	60-70	5-15	0.63-2.00	0.17-0.19	Low.
-----	100	90-100	60-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	75-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	80-100	40-60	0.06-0.63	0.18-0.22	High.
-----	------	100	75-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	95-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	97-100	35-45	0.06-0.20	0.18-0.20	High.
-----	------	100	95-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	75-100	10-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	60-100	25-35	0.63-2.00	0.18-0.22	Moderate to high.
-----	-------	100	75-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	90-100	5-20	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	95-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	90-100	5-20	0.63-2.00	0.20-0.22	Moderate.

Soil series and map symbols	Depth to seasonal high water table	Depth to sand or mixed sand and gravel	Depth from surface of typical profile	Classification 1/		
				USDA	Unified	AASHO
	Feet	Feet	Inches			
*Holdrege: Ho, HoA, HoA2, HoB, HoB2, HoC, HwB3, HCC2. For Coly part of HCC2, see Coly series.	(4/)	(5/)	0-13	Silt loam--------	ML or CL	A-4 or A-6
			13-30	Light silty clay loam.	CL	A-6 or A-7
			30-60	Silt loam--------	ML or CL	A-4 or A-6
Hord: Hd, 2Hd--------------	(4/)	(5/)	0-19	Silt loam--------	CL	A-6
			19-38	Silt loam--------	CL	A-6
			38-60	Silt loam--------	CL	A-6
*Kenesaw: Ks, 2KsA, KCA, 2KC, 2KC2. For Coly part of KCA, 2KC, and 2KC2, see Coly series.	(4/)	(5/)	0-20	Silt loam--------	ML or CL	A-4 or A-6
			20-60	Silt loam--------	ML or CL	A-4
Leshara: Le----------------	3-6	3-6	0-12	Silt loam--------	CL	A-4 or A-6
			12-36	Silt loam--------	CL	A-4
			36-50	Fine sandy loam--	ML or ML-CL	A-4
			50-60	Sand and gravel--	SP-SM or SP	A-2
2Le-----------------------	3-6	3-6	-----	-----------------	-----------	----------
Loamy alluvial land: Lx----	1-2	½-2	-----	-----------------	-----------	----------
Marsh: M------------------	At surface.	----	-----	-----------------	-----------	----------
Meadin: 2Md---------------	5-10	1-2	0-12	Loamy sand-------	SP-SM or SM	A-2 or A-4
			12-60	Sand and gravel--	SP	A-1
2Mw-----------------------	5-10	1-2	0-9	Silt loam--------	ML or CL	A-4 or A-6
			9-14	Loam-------------	SM or ML	A-4
			14-28	Sand and gravel--	SP	A-1
O'Neill: On---------------	5-10	1-3	0-10	Fine sandy loam--	SM	A-2 or A-4
			10-24	Sandy loam-------	SM	A-2 or A-4
			24-60	Sand and gravel--	SP or SP-SM	A-1
*Platte: P, 2PW------------ For Wann part of 2PW, see Wann series.	1½-3½	1½-3	0-8	Silty clay loam--	CL or CH	A-6 or A-7
			8-17	Sandy loam-------	SM	A-2 or A-4
			17-50	Sand and gravel--	SP	A-1
Rough broken land, loess: RB	(4/)	(5/)	0-60	Silt loam--------	CL	A-4 or A-6
Rusco: Ru-----------------	(4/)	(5/)	0-7	Silt loam--------	ML or CL	A-4
			7-20	Silty clay loam and silt loam.	CL	A-6
			20-60	Silt loam--------	ML or CL	A-4

See footnotes at end of table.

Percentage passing sieve 2/--				Percentage finer than 0.002 mm.	Permeability	Available water capacity 3/	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200				
					Inches per hour	Inches per inch of soil	
-----	------	100	96-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	98-100	20-35	0.63-2.00	0.18-0.20	Moderate to high.
-----	------	100	97-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	90-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	90-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	90-100	10-27	0.63-2.00	0.20-0.22	Moderate.
-----	------	100	98-100	15-27	0.63-2.00	0.22-0.24	Low to moderate.
-----	------	100	98-100	10-27	0.63-2.00	0.20-0.22	Low.
-----	100	95-100	75-90	10-27	0.63-2.00	0.22-0.24	Moderate.
-----	100	95-100	60-100	10-27	0.63-2.00	0.20-0.22	Low.
-----	100	95-100	60-100	5-20	2.00-6.30	0.14-0.16	Low.
50-90	30-70	5-40	0-12	0-2	>20.0	0.02-0.04	Low.
-----	------	------	------	-----	---------	---------	
-----	------	------	------	-----	---------	---------	
-----	------	------	------	-----	---------	---------	
96-98	90-98	35-90	5-50	5-10	6.30-20.0	0.10-0.12	None.
85-95	70-80	35-60	0-5	0-2	>20.0	0.02-0.04	None.
96-98	90-98	85-95	70-95	10-27	0.63-2.00	0.22-0.24	Moderate.
90-95	85-90	35-60	35-93	10-20	0.63-2.00	0.17-0.19	Low.
85-95	70-80	5-40	0-5	0-2	>20.0	0.02-0.04	None.
100	95-100	85-90	30-49	5-20	2.00-6.30	0.16-0.18	Low.
98	95-98	85-90	15-50	0-15	2.00-6.30	0.12-0.14	Low.
90-100	90-98	70-90	0-10	0-2	>20.0	0.02-0.04	None.
------	100	95-100	85-95	27-40	0.20-0.63	0.21-0.23	High.
97-98	70-90	30-60	15-45	5-20	2.00-6.30	0.12-0.14	Low.
94-95	15-50	------	0-5	0-2	>20.0	0.02-0.04	None.
------	100	95-100	90-100	10-27	0.63-2.00	0.20-0.22	Moderate.
------	------	100	98-100	15-27	0.63-2.00	0.22-0.24	Low.
------	------	100	98-100	27-40	0.20-0.63	0.18-0.20	Moderate.
------	------	100	98-100	15-27	0.63-2.00	0.20-0.22	Low.

Soil series and may symbols	Depth to seasonal high water table	Depth to sand or mixed sand and gravel	Depth from surface of typical profile	Classification 1/		
				USDA	Unified	AASHO
	Feet	Feet	Inches			
Scott: Sc------------------	(4/)	(5/)	0-6	Silt loam--------	ML or CL	A-4 or A-6
			6-48	Silty clay and silty clay loam.	CL or CH	A-7
			48-60	Silt loam--------	CL	A-6 or A-7
Thurman: 2Th---------------	5-10	2-4	0-14	Loamy fine sand--	SM	A-2
			14-52	Loamy fine sand--	SM	A-2
			52-60	Sand and gravel--	SP-SM	A-1 or A-2
Valentine: VcB-------------	(4/)	(5/)	0-12	Loamy sand-------	SP-SM or SM	A-2
			12-60	Fine sand--------	SP-SM or SM	A-2 or A-3
Wann: Wb-------------------	2-5	3-5	0-16	Fine sandy loam--	SM	A-2 or A-4
			16-60	Sandy loam-------	SP-SM or SM	A-2 or A-4
Wm------------------------	2-5	3-5	0-10	Loam and very fine sandy loam.	ML or SM	A-4
			10-60	Fine sandy loam--	SM	A-2 or A-4
2Wm-----------------------	2-5	3-5	-----	-----------------	-----------	----------

1/ Where two classifications are shown, the one listed first is the more common.

2/ Pebbles 3 inches or more in diameter were excluded from samples tested.

3/ Values of available water capacity are averages based on water retention difference, as determined by laboratory tests.

Percentage passing sieve 2/-- No. 4	No. 10	No. 40	No. 200	Percentage finer than 0.002 mm.	Permeability	Available water capacity 3/	Shrink-swell potential
					Inches per hour	Inches per inch of soil	
-----	100	95-100	85-100	15-27	0.63-2.00	0.22-0.24	Moderate.
-----	------	100	98-100	40-60	<0.06	0.11-0.13	High.
-----	------	100	85-100	15-27	0.63-2.00	0.20-0.22	Moderate.
-----	100	88-100	15-40	5-15	6.30-20.0	0.10-0.12	None.
-----	100	85-100	15-30	2-10	6.30-20.0	0.09-0.11	None.
100	90-100	50-85	5-12	0-2	>20.0	0.02-0.04	None.
-----	100	90-100	5-30	0-10	6.30-20.0	0.10-0.12	None.
-----	100	90-100	5-20	0-5	6.30-20.0	0.06-0.08	None.
100	90-100	85-100	30-49	10-20	2.00-6.30	0.16-0.18	Low.
100	95-100	80-90	20-40	5-15	2.00-6.30	0.12-0.14	Low to none.
100	95-100	85-95	40-75	7-25	0.63-2.00	0.20-0.22	Moderate.
100	95-100	80-95	30-49	5-20	2.00-6.30	0.15-0.17	Low.
-----	------	------	------	-----	---------	---------	

4/ Water table is at a depth too great to be significant in engineering.

5/ Sand or mixed sand and gravel occur below the depth normally sampled.

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more it is necessary to follow carefully the instructions for referring to other series that appear in the first land types is too variable]

Soil series and map symbol	Suitability as source of-- Topsoil	Sand or mixed sand and gravel	Road subgrade: Paved	Road subgrade: Gravel	Road fill	Soil features affecting-- Highway location	Foundations	Dikes and levees
Anselmo: AnA, AnB, AnB2, AnC, 2AnA, Ag, 2Ag.	Fair-----	(1/)----	Good to fair.	Fair---	Good to fair.	Susceptible to frost action if surface soil is used as subgrade; slopes erodible.	Good to fair bearing capacity depending on density and moisture; subject to seepage in places.	Slopes erodible; subject to seepage.
Butler: Bu, 2Bu----	Fair-----	(1/)----	Poor-----	Good---	Poor-----	Highly susceptible to frost action owing to clay content; subject to occasional flooding or ponding; minimum fills required in places; slopes erodible.	Fair to poor bearing capacity.	Slopes erodible.
Cass: Cs-----------	Fair-----	Fair below depth of 3 feet.	Fair-----	Fair---	Fair-----	Where clayey, susceptible to frost action if moist; slopes highly erodible.	Good to fair bearing capacity; subject to seepage in places.	Slopes erodible; subject to seepage.
*Coly: CbD, CKC---- For Kenesaw part of CKC, see Kenesaw series.	Fair-----	(1/)----	Fair-----	Good---	Fair-----	Highly susceptible to frost action; slopes highly erodible; deep cuts and thick fills necessary.	Fair to poor bearing capacity; excessive consolidation when wetted and loaded.	Slopes erodible.
Cozad: Coz---------	Good----	(1/)----	Fair to poor.	Good---	Fair-----	Moderately susceptible to frost action; slopes erodible.	Fair to poor bearing capacity depending on density and moisture.	Slopes erodible.

See footnotes at end of table.

kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason column of this table. No interpretations are given for Marsh and Spoil banks because the soil material in these

Soil features affecting--Continued: Farm ponds: Reservoir area	Soil features affecting--Continued: Farm ponds: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree and kind of limitation affecting--: Septic tank filter fields	Degree and kind of limitation affecting--: Sewage lagoons
Moderate to high seepage rate.	Fair stability; compaction control needed; low compressibility.	Good internal drainage; excessively drained in places.	Moderate available water capacity, subject to soil blowing where not protected.	Layout of terraces difficult; slopes subject to soil blowing and water erosion.	Subject to soil blowing and water erosion; underlying sand exposed in deep cuts.	Slight------	Severe: moderately rapid permeability necessitates sealing or lining of sides and bottom.
Low seepage rate.	Good to fair stability; impervious; fair to poor workability, depending on moisture.	Subject to occasional overflow and ponding; cutting outlets for ponded water commonly not feasible; poor internal drainage.	High available water capacity; slow intake rate; protection from flooding needed; surface drainage necessary.	Slopes of diversion channels moderately erodible.	Moderately erodible; grasses should be tolerant of excess water.	Severe: slow permeability; flooding likely on unit 2Bu.	Slight for unit Bu; severe for unit 2Bu because of frequent flooding.
Moderate seepage rate.	Good to fair stability; compaction control needed; requires drainage in places; good workability.	Generally good internal drainage.	Moderate available water capacity.	Slopes of diversion channels erodible.	Erodible; underlying sand exposed in deep cuts.	Slight------	Severe: moderately rapid permeability necessitates sealing or lining.
Low to moderate seepage; high vertical seepage rate.	Good to fair stability; slopes highly erodible; good to fair compaction if moisture content is controlled.	Rapid surface drainage; good internal drainage.	High available water capacity; steep slopes erodible; unit CbD not suitable.	Slopes erodible; low fertility if subsoil is exposed; construction and maintenance likely to be costly.	Highly erodible; maintenance likely to be costly.	Severe: steep slopes; moderate with respect to seepage.	Severe: steep slopes and high vertical seepage make compaction difficult.
Low to moderate seepage rate.	Good to fair stability.	Good external and internal drainage.	High available water capacity.	Slopes erodible.	Erodible----	Moderate: moderate permeability.	Moderate: moderate permeability necessitates sealing in places.

Soil series and map symbol	Suitability as source of-- Topsoil	Sand or mixed sand and gravel	Road subgrade: Paved	Road subgrade: Gravel	Road fill	Soil features affecting-- Highway location	Foundations	Dikes and levees
Crete: Ce----------	Good to fair.	(1/)---	Poor----	Good---	Poor----	Highly susceptible to frost action; slopes erodible; moderate to high shrink-swell potential.	Fair to poor bearing capacity.	Slopes erodible; moderate to high shrink-swell potential.
Detroit: De--------	Fair----	(1/)---	Poor----	Good---	Fair to poor.	Moderately to highly susceptible to frost action; slopes erodible; moderate to high shrink-swell potential.	Fair to poor bearing capacity.	Slopes erodible; fair stability.
Grigston: Gp-------	Good----	(1/)---	Fair to poor.	Good---	Fair----	Highly susceptible to frost action; slopes erodible.	Fair to poor bearing capacity.	Slopes erodible.
Hobbs: Hb, 2Hb------	Good----	(1/)---	Fair-----	Good---	Fair----	Highly susceptible to frost action; slopes erodible.	Fair to poor bearing capacity.	Slopes erodible.
*Holdrege: Ho, HoA, HoA2, HoB, HoB2, HoC, HwB3, HCC2, For Coly part of HCC2, see Coly series.	Good----	(1/)---	Fair-----	Good---	Fair----	Highly susceptible to frost action; slopes erodible.	Fair to poor bearing capacity; excessive consolidation when wetted and loaded.	Slopes erodible.
Hord: Hd, 2Hd-------	Good----	(1/)---	Fair----	Good---	Fair----	Highly susceptible to frost action; slopes erodible.	Fair to poor bearing capacity; excessive consolidation when wetted and loaded.	Slopes erodible.

See footnotes at end of table.

Soil features affecting--Continued							Degree and kind of limitation affecting--	
Farm ponds								
Reservoir area	Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Low seepage; usable for dugouts.	Good to fair stability; impervious when compacted; fair workability.	Poor internal drainage.	High available water capacity; slow intake rate.	Moderately erodible.	Moderately erodible; subsoil lacks fertility in places.	Severe: slow permeability.	Slight.
Low seepage rate.	Fair stability; impervious; good to fair compaction; slopes erodible.	Fair internal drainage.	High available water capacity.	Moderately erodible.	Moderately erodible.	Severe: slow permeability.	Slight: impervious if compacted.
Low seepage rate.	Good to fair stability; compaction control needed; impervious; fair workability.	Generally good internal and external drainage.	High available water capacity.	(2/)---------	Generally satisfactory.	Moderate: moderate permeability.	Moderate: moderate permeability; impervious when compacted and sealed.
Low to moderate seepage; high vertical seepage.	Good to fair stability; compaction control needed.	Good to fair internal and external drainage; subject to overflow in places.	High available water capacity; unit Hb susceptible to flooding in places.	Slopes erodible; subject to flooding in places.	Moderately erodible; maintenance cost high where subject to flooding.	Moderate: moderate permeability.	Moderate: moderate permeability; protection from overflow needed.
Low seepage rate; high vertical seepage.	Good to fair stability; good to fair compaction; slopes erodible.	Generally good internal and external drainage.	High available water capacity; steeper slopes erodible; development costs high on steeper slopes.	Moderately erodible.	Erodible; fertility problem likely where subsoil is exposed; maintenance costs high in places.	Moderate: moderate permeability.	Moderate: moderate permeability; moderately steep slopes in places; impervious when compacted and sealed.
Low seepage; high vertical seepage.	Good to fair stability; compaction control needed; slopes erodible; good to fair workability.	Good internal and external drainage.	High available water capacity.	Moderately erodible.	Erodible----	Moderate: moderate permeability.	Moderate: moderate permeability; sealing needed in places.

Soil series and map symbol	Suitability as source of-- Topsoil	Sand or mixed sand and gravel	Road subgrade: Paved	Road subgrade: Gravel	Road fill	Soil features affecting-- Highway location	Foundations	Dikes and levees
*Kenesaw: Ks, 2KsA, KCA, 2KC, 2KC2. For Coly part of KCA, 2KC, and 2KC2, see Coly series.	Fair----	(1/)---	Fair----	Good---	Fair----	Highly susceptible to frost action; slopes erodible.	Fair to poor bearing capacity; excessive consolidation when wetted and loaded.	Slopes erodible.
Leshara: Le, 2Le----	Good to depth of 4 feet.	Good below depth of 4 feet.	Fair----	Good to fair to depth of 4 feet.	Good to fair.	Surface soil susceptible to frost action; high water table necessitates raising of grade in places; slopes erodible.	Bearing capacity depends on depth of footings or structure.	Slopes erodible; high horizontal seepage in sand strata.
Loamy alluvial land: Lx.	Poor----	Good---	--------	-------	--------	Water table occasionally rises to near land surface; fill of 4 feet or more required in places.	Drainage necessary for excavations.	High water table.
Meadin: 2Md, 2Mw----	Poor below depth of 1 foot.	Good below depth of 1 foot.	Good----	Poor---	Good----	Low susceptibility to frost action; slopes erodible; loose sand below depth of 1 foot hinders loading in some places; fills must be confined for stability.	Good bearing capacity where sand is confined.	Highly permeable; subject to horizontal seepage.

See footnotes at end of table.

Soil features affecting--Continued						Degree and kind of limitation affecting--	
Farm ponds							
Reservoir area	Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Moderate seepage rate; high vertical seepage.	Good to fair stability; compaction control needed; good to fair compaction; moderate compressibility; slopes erodible.	Generally good internal drainage.	High available water capacity.	Slopes very erodible; silting of channel likely to result in high maintenance costs.	Erodible; low fertility likely to be a problem where subsoil is exposed.	Moderate: moderate permeability.	Moderate: moderate permeability; compaction or sealing needed in places.
Moderately high seepage rate.	Good to fair stability when confined; low compressibility; two types of soil available; wet in places.	Good to fair internal drainage; slow to medium external drainage; adequate openings not available in some places.	High available water capacity; adequate drainage needed; subirrigation.	(2/)----------	Erodible; drainage needed in places where grasses are not water tolerant.	Severe: moderately high water table.	Moderate: moderate permeability; excavation likely to expose sand strata; sealing or lining needed.
Suitable for dugouts.	(2/)----------	High water table.	(2/)---------	(2/)----------	(2/)--------	Severe: very high water table.	Severe: very rapid permeability; sealing or lining needed.
Very high seepage rate.	Good to fair stability; low compressibility below surface soil; pervious; subject to horizontal seepage in places; slopes erodible; good to fair workability.	Good internal drainage; excessively drained below depth of 1 foot in places.	Very low available water capacity.	Erodible; construction and maintenance costs likely to be high.	Erodible; low fertility; maintenance costs likely to be high.	Slight------	Severe: rapid permeability; sealing or lining needed.

Soil series and map symbols	Suitability as source of-- Topsoil	Sand or mixed sand and gravel	Road subgrade: Paved	Road subgrade: Gravel	Road fill	Soil features affecting-- Highway location	Foundations	Dikes and levees
O'Neill: On--------	Good in surface layer; poor below.	Good below depth of 2 feet.	Good-----	Poor---	Good----	Low susceptibility to frost action; slopes highly erodible; loose sand below depth of 2 feet likely to hinder hauling operations; suitability based on sand strata.	Good bearing capacity where sand is confined; subject to horizontal seepage in places.	Fair stability; slopes erodible; compaction control needed to reduce seepage.
*Platte: P, 2PW----- For Wann part of 2PW, see Wann series.	Poor----	Good below depth of 1 foot.	Good-----	Poor---	Good----	Low susceptibility to frost action; high water table and susceptibility to flooding; fill of 4 feet or more required in some places; slopes highly erodible; suitability based on sand strata.	Good bearing capacity where sand is confined; likely to be wet.	Slopes must be very gentle; subject to horizontal seepage.
Rough broken land, loess: RB.	Poor----	(1/)----	Fair-----	Good---	Fair----	Susceptible to frost action; slopes highly erodible; deep cuts and thick fills necessary.	Fair to poor bearing capacity; excessive consolidation when wetted and loaded.	(2/)----------
Rusco: Ru----------	Fair----	(1/)----	Fair-----	Good---	Fair----	Moderate susceptibility to frost action; protection from flooding needed; slopes moderately erodible.	Fair to poor bearing capacity, depending on moisture, density, and load.	Low seepage rate; slopes erodible.
Scott: Sc----------	Poor----	(1/)----	Poor-----	Good---	Poor----	Moderate to high susceptibility to frost action; slopes erodible; fills needed where subject to ponding.	Fair to poor bearing capacity; moderate to high shrink-swell potential; excessive consolidation when wetted and loaded.	Subject to cracking owing to shrinkage; slopes erodible.

See footnotes at end of table.

Soil features affecting--Continued							Degree and kind of limitation affecting--	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways		Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment							
High seepage rate.	Good to fair stability; low compressibility below depth of 2 feet; good workability; possible horizontal seepage.	Good internal drainage; excessively drained below depth of 2 feet in places.	Low available water capacity; steeper slopes erodible; likely to be droughty; susceptible to soil blowing.	Erodible; loose sand below depth of 2 feet; likely to be susceptible to soil blowing and water erosion.	Erodible; low fertility; likely to be droughty; susceptible to soil blowing and water erosion; maintenance costs likely to be high.		Slight-----	Severe: rapid permeability below depth of 2 feet; sealing or lining needed; embankments subject to piping.
High seepage rate; high water table; suitable for dugouts.	Good stability; compaction control needed; generally low compressibility; surface soil used as impervious core in fills; drainage required in places; good workability.	Fair to poor internal drainage; drainage outlets not available in places; seasonally high water table; subject to flooding.	Shallow to sand and gravel; low available water capacity; subirrigation; provision for drainage and protection from flooding needed.	(2/)----------	Erodible; low fertility where subsoil is exposed; protection from flooding needed; water-tolerant grasses needed in some places.		Severe: seasonally high water table; subject to flooding.	Severe: moderately rapid permeability; protection from flooding needed; sealing or lining needed.
High vertical seepage.	Good to fair stability and compaction; impervious; slopes erodible.	Rapid surface runoff; excessively drained.	(2/)---------	(2/)----------	(2/)---------		Severe: steep slopes.	Severe: steep slopes.
Low seepage rate; moderate vertical seepage.	Fair stability; good workability with compaction control; impervious when compacted.	Fair to poor drainage; subject to flooding.	High available water capacity.	(2/)----------	(2/)---------		Moderate: moderately slow permeability; subject to flooding.	Slight: compaction to control seepage needed in some places.
Low seepage rate.	Good to fair stability; imervious; fair to poor workability; slopes erodible; compaction control needed.	No surface drainage; slow internal drainage; subject to frequent flooding; adequate drainage outlets at reasonable cost not available in places.	(2/)---------	Diversion slopes erodible; terraces generally not needed.	Highly erodible; fertility low in places.		Severe: very slow permeability; subject to ponding.	Severe: protection from flooding needed.

Soil series and map symbols	Suitability as source of--					Soil features affecting--		
	Topsoil	Sand or mixed sand and gravel	Road subgrade		Road fill	Highway location	Foundations	Dikes and levees
			Paved	Gravel				
Thurman: 2Th------	Fair to poor.	Coarse to very fine sand below depth of about 2 feet. Locally contains small amount of gravel.	Good----	Poor----	Good-----	Low susceptibility to frost action; slopes highly erodible and subject to soil blowing and water erosion; loose sand below depth of 2 feet likely to hinder loading and hauling operations; fills must be confined for stability.	Good bearing capacity, depending on density. Hydraulic structures subject to seepage.	Slopes erodible; seepage control needed in places.
Valentine: VcB----	Poor----	Fair for fine sand; no gravel.	Good----	Poor----	Good-----	Not susceptible to frost action; highly susceptible to soil blowing and water erosion; difficult to vegetate; slope protection needed; fills must be confined for stability.	Good to fair bearing capacity, depending on density; good shear strength; must be confined.	Subject to soil blowing and water erosion; slopes need protection.
Wann: Wb, Wm, 2Wm-	Fair----	Fair for fine sand; no gravel.	Fair----	Fair----	Good-----	Moderate to low susceptibility to frost action; slopes erodible; subject to high water table and occasional flooding; minimum fills needed in some places; suitability depends on differences in gradation.	Bearing capacity depends on density; subject to seepage in some places.	Slopes erodible; seepage control needed in some places.

1/ Generally not available.

Soil features affecting--Continued						Degree and kind of limitation affecting--	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankments						
High to moderate seepage rate.	Good to fair stability; good to fair workability; low compressibility; seepage control needed in some places; special hauling equipment needed in some places.	Good internal drainage.	Low available water capacity; droughty; subject to severe soil blowing; rapid intake rate.	Subject to soil blowing and water erosion; desirable layouts difficult owing to irregular topography; maintenance costs likely to be high.	Droughty; subject to soil blowing and water erosion; maintenance costs likely to be very high.	Slight------	Severe: rapid permeability; sealing or lining needed.
High seepage rate.	Good stability; good to fair workability; low compressibility.	Excessively drained.	(2/)----------	Erodible by water and subject to soil blowing.	Erodible by water and subject to soil blowing; fertility likely to be low where excavations are deep.	Slight------	Severe: rapid permeability; sealing or lining needed.
High to moderate seepage rate; suitable for dugouts where water table is high.	Fair to poor stability above substratum; fair to poor for substratum; low compressibility.	Generally good internal drainage; subject to high water table and occasional flooding; adequate outlets not available in some places; if drained, moisture likely to be deficient during dry periods.	High available water capacity; adequate drainage needed.	Diversion slopes erodible; protection from overflow needed; terraces generally not needed.	Erodible; protection from overflow needed.	Moderate: water table likely to be too high.	Severe: moderately rapid permeability; sealing or lining needed.

2/ Because of position or slope, this practice or structure generally is not needed or is not applicable.

sandy soils are nonplastic and thus do not become plastic at any moisture content.

Estimated Engineering Properties

Table 6 shows estimated engineering properties of the soils based on the test data in table 5 and on other information obtained in the county during the survey. The sections "Descriptions of the Soils" and "Formation and Classification of the Soils" give more detailed information about the soils and geology. The data, listed by strata that have properties significant to engineering, include the USDA textural classification and the AASHO and Unified engineering classifications.

Table 6 also gives, for each layer, the percentage of particles that pass a No. 4 sieve, a No. 10 sieve, a No. 40 sieve, and a No. 200 sieve, and the percentage finer than 0.002 millimeter. Estimates of the percentage passing the various sieves were determined by the hydrometer method and are based on the assumption that material up to and including 3 inches in diameter equals 100 percent. No soil in Phelps County has a significant percentage of materials greater than 3 inches in diameter. In the AASHO and Unified systems, soil particles retained on the No. 200 sieve are classified as sand and gravel. Silt and clay particles pass through this sieve. The range of values for the percentage of soil finer than 0.002 millimeter in diameter represents the clay fraction of the soil. Because the clay percentages in tables 5 and 6 are based on an analysis using the hydrometer method (AASHO Designation T-88), the results may differ slightly from those obtained from the pipette method used by soil scientists in the Soil Conservation Service.

Silt and clay particles affect such properties as permeability, available water capacity, and shrink-swell potential. Permeability is the rate at which water moves through an undisturbed, saturated soil. It depends on the texture, gradation, structure, and density of the soil and is measured in inches of water per hour. Available water capacity, expressed in inches of water per inch of soil depth, is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of water in a soil at field capacity and the amount at wilting point. Shrink-swell potential is an indication of the volume change to be expected in a soil when the soil moisture is changed. It is rated low, moderate, or high. Generally, soils with a high clay content have a high shrink-swell potential, and clean sands and gravels have a low shrink-swell potential. Several soils in Phelps County, such as those in the Butler, Crete, and Scott series, have moderate to high shrink-swell potential.

Important engineering properties not included in table 6 are soil reaction and dispersion. Reaction of a soil is the degree of acidity or alkalinity expressed as a pH value or reaction class. A soil that has a pH of 7.0 is neutral, one that has a lower value is acid, and one that has a value greater than 7.0 is alkaline. In Phelps County, most soils have pH values greater than 7.8. The reaction class for most horizons of the representative profiles are given in the section "Descriptions of the Soils." Soils used as construction materials need to be tested for potential corrosivity to metal structures. Dispersion is the deflocculation of a soil and its suspension in water. Salinity is a major factor in soil dispersion, but it is not a serious problem in Phelps County. Only the somewhat poorly drained bottom land along the Platte River and the saline phases of the Leshara and Wann soils contain salts in amounts that produce moderate dispersion. Onsite investigations need to be made in areas where salinity is a hazard to construction work.

Engineering Interpretations

In table 7 the soils are rated as sources of topsoil and of sand or mixed sand and gravel and as material for road subgrade and fill. Soil features affecting highway location, foundations, dikes and levees, farm ponds, drainage, irrigation, terraces and diversions, and grassed waterways are summarized. Also listed are soil limitations for sewage disposal. This table is a guide to planning and to further investigations of the soils. Onsite invewtigation should be made before beginning construction.

Topsoil is fertile soil material that ordinarily is rich in organic matter. It is used as a top layer for excavated slopes, road and dam embankments, lawns, and gardens. The soils are rated good, fair, or poor as sources of topsoil. Soils that are rated poor or fair to poor generally are low in organic-matter content or natural fertility, or they have a surface layer that is sticky or difficult to work.

Sand and gravel occur at shallow depths in several soils in Phelps County. Cass, Meadin, O'Neill, and Platte soils and others are rated good or fair as sources of sand or mixed sand and gravel. Further exploration is needed to determine the quantity and gradation of these materials. Operational sandpits are a guide in locating sources of sand and gravel.

Properly confined sand is the best subgrade for paved roads, whereas silt and clay are the best subgrade for gravel roads. Ratings for use as subgrade are derived from the AASHO classification of the soil material as follows:

Ratings for subgrade:	AASHO classification
Paved roads:	
Good-------------------	A-1 or A-3
Good to fair-----------	A-2
Fair to poor-----------	A-4
Poor-------------------	A-6 or A-7
Gravel roads:	
Poor-------------------	A-1 or A-3
Fair to poor-----------	A-2
Good to fair-----------	A-4
Good-------------------	A-6 or A-7

The rating of a soil for use as road fill is generally the same as the rating for its use as subgrade for paved roads. Ratings for use as embankments or as foundations for embankments are the same as the ratings for use as road fill.

Factors affecting highway location are the susceptibility of the soil to frost action, the shrink-swell potential of the soil, the erodibility of the soil on cut and fill slopes, and the depth to the water table. Silt and clay are subject to frost action, which is the expansion that results from water freezing in the soil. A high water table contributes to frost action or frost heave and increases the maintenance needed for paved roads.

An important property that affects the use of a soil for foundations is its bearing, or load-carrying, capacity. Bearing capacity is rated in table 7 as poor, fair, or good. Specific values (in pounds per square inch, for example) should not be assigned to these interpretations.

Most soils have a high bearing capacity when dry. Some soils are subject to excessive consolidation when wetted and loaded. Sands and gravels have a high bearing capacity when confined. All soils that have a high water table should be thoroughly investigated before starting the building of any structure The shrink-swell potential (see table 6) also is an important property affecting foundations.

Dikes and levees are used to control surface water. They are subject to erosion by wind and water and also to horizontal seepage if not properly compacted or if constructed of clean sands. Some soils are subject to cracking and shrinking upon drying. Gentle slopes are needed for stability where dikes and levees are constructed of sandy soils. Steeper slopes can be used for clay soils, which are relatively impervious to water.

Most farm ponds and reservoirs lose water through seepage. To reduce this loss, ponds built from soils underlain by sand, or from the part of soils lying above the water table, need to be sealed or lined. In soils that have a high water table, a water supply can sometimes be obtained by excavating a dugout pond.

Soils used for embankments that serve as low dams must be subjected to compaction. Some soils in Phelps County can be compacted by the use of sheepsfoot rollers, but those containing approximately 15 percent or less of silt and clay particles, as determined by the relative density test, should be compacted by vibratory methods. (See table 5 for maximum dry densities for particular soil samples.) Embankments are subject to water erosion and seepage. Potential seepage depends on moisture gradation and compaction of the fill. In table 7 the soils are rated as to their stability after compaction, and also as to their workability after compaction. The workability depends on hauling and compaction characteristics.

Some soils in Phelps County have poor natural drainage because of a high water table, slow permeability, or both. A few are subject to flooding, and others are nearly level and have slow runoff. The kinds of drainage that can be used effectively for agricultural purposes depend on permeability, relief, depth to the water table, and the availability of outlets. (See table 7.)

Factors affecting the suitability of a soil for irrigation are available water capacity, permeability, surface intake rate, steepness of slopes, and possibly, limits on how deep a cut can be made to level the soil. The ratings for the available water capacity in the irrigation column of table 7 are for the top 5 feet of soil. The available water capacity is high if the soil holds 9 inches of water in the top 5 feet; moderate if the soil holds 6 to 9 inches; low if the soil holds 3 to 6 inches; and very low if the soil holds less than 3 inches. The intake rate is the amount of water, in inches per hour, that enters the soil under irrigation and depends upon the permeability of the soil. A rapid intake rate is more than 2 inches of water per hour; a moderate rate is from 0.5 to 2 inches per hour; and a slow rate is less than 0.5 inch per hour.

Suitability of soils for terraces, diversions, and grassed waterways depends on susceptibility to erosion by wind or water, fertility, and difficulty of establishing vegetation. Most terrace slopes are erodible and need maintaining. Maintenance can be costly where siltation from higher elevations occurs. The depth to erodible sand limits the cutting depth that can be allowed for diversion alinement. Rough topography and steep slopes are also factors in alinement of terraces and diversions.

Factors affecting the use of soils for septic tank filter fields and for sewage lagoons are soil permeability, depth to water table, and susceptibility to flooding.

For filter fields, the limitation of a soil is slight if the soil has a high infiltration rate and contamination of ground water is not likely; the limitation is moderate if the soil has moderate permeability; and the limitation is severe if the soil is impervious or the water table is high.

Sewage lagoons must retain liquids long enough for aerobic decomposition of fresh sewage to occur. The limitation of an impervious soil for lagoons is slight; that of somewhat more permeable soils is moderate; and that of rapidly permeable soils is severe. Some soils that have moderate limitations can be used if the sides and bottom of lagoons are sealed with bentonite or sodium carbonate, or if lined with a commercial plastic or rubber liner.

Sewage filter fields and disposal lagoons should be located so as not to contaminate water supplies for domestic use or for livestock.

The first part of this section is a discussion of the factors affecting formation and development of the soils in Phelps County. The second part explains the system of soil classification currently used and classifies the soil series of the county according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on parent material that accumulated through the weathering of rock. The characteristics of the soil at any given place depend on the physical and mineralogical composition of the parent material; on the climate during the period of soil formation; on the plant and animal life in and on the soil since the beginning of its formation; on the relief, or lay of the land; and on the length of time the forces of soil formation have acted on the soil material.

Climate and plants and animals are the active factors of soil formation. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Usually, long periods of time are needed to change the parent material into a soil and for differentiating the soil into distinct horizons.

The factors of soil formation are closely interrelated in their effects on the soil. Few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are not known.

Parent Material

Parent material is the disintegrated and partly weathered rock in which soil forms. The soils of Phelps County formed in several kinds of parent material, but mostly in loess, eolian sand, and alluvium. Some soils formed in more than one kind of material, and others formed in various mixtures of materials from different sources.

Loess, or wind-deposited silt, is the parent material of soils throughout all but the northeastern part of the county and the stream valleys. Much of this is Peoria loess, which is a uniform light-gray to very pale brown silt loam (pl. IV, bottom) that ranges from 20 to 45 feet in thickness. Butler, Coly, Detroit, Holdrege, Scott, and the upland Hord soils formed in this material. In the northeastern part of the county, the upland areas of Kenesaw soils and some Coly soils formed in a wind-deposited silt that is younger than Peoria loess. In places where Hord and Kenesaw soils are on terraces, the parent material capping the terraces was probably loessal in origin. No soil in the county developed in Loveland loess, which crops out on the lower parts of steep slopes in the southwestern part of the county. The Loveland loess is reddish to strong brown and is the oldest loess material.

Eolian sand is the parent material throughout much of the northeastern part of the county. It was blown mostly from the bottom lands in the valley of the Platte River and consists of well-sorted, clean grains, generally of quartz. Valentine soils formed in eolian sand.

Alluvium, or stream-deposited sediment, is the parent material of soils in the valley of the Platte River and in the lower parts of narrow bottoms and canyons. The older alluvium occurs as terraces and is moderately coarse textured to coarse textured.

Because the upper part of this older alluvium was reworked by the wind, the parent material of the soils on the terraces is to limited degree of eolian origin. Meadin, O'Neill, Thurman, and some Anselmo and Valentine soils developed on older alluvium reworked by wind. The most recently deposited alluvium is on bottom lands along the Platte River. The Leshara, Platte, Grigston, and Wann soils formed in this fine-textured to coarse-textured alluvium. Cozad and Hobbs soils formed in alluvium washed from adjacent loess uplands.

Climate

Climate influences the formation of soils through its influence on the rate of weathering and reworking of parent material by rainfall, temperature, and wind. Phelps County is located in the western part of a vast subhumid interior belt that extends from Texas to Canada. The climate is reasonably uniform throughout the county, and the soils formed in a climate much like that of the present. In young soils, the climatic influence on the original grass vegetation is reflected in the low organic-matter content and the thin, slightly darkened A horizon.

The average annual precipitation at Holdrege is 23 inches. Most of this precipitation occurs during April, May, June, and July. Hard dashing rains, which come frequently as local thunderstorms during the spring and early summer, cause erosion of sloping soils. Erosion from rain that does not penetrate is a greater hazard where the soil is cultivated than where it is protected by cover crops or grasses. Rainfall has leached the lime in nearly level, silty loess soils to depths ranging from 2 to 3 feet. In sandy soils, which have more rapid permeability, leaching to depths greater than 3 feet is common. Translocation of clay has taken place in some soils.

Because slopes facing south and west are directly exposed to the sun's rays during the hotter part of the day, they are drier than slopes facing east or north.

The average annual temperature at Holdrege is 53° F. Wide variations in temperature occur in all

seasons. Temperatures below zero are common in winter, and temperatures above 100 degrees are common in summer. Freezing of moist soils during winter generally improves their workability in spring. In contrast, hot wind in summer can have a severe drying effect on soils.

The hummocky and undulating topography in the northeastern part of the county is related to the eolian origin of the soils. Even now, sediment deposited by the wind is being added to and mixed with the surface layer of all soils in the county. Some soils lose more material through wind action than they gain.

Plants and Animals

Trees, grass and forbs, small burrowing animals, earthworms, micro-organisms, and other plants and animals on and in the soil are all active in the soil-forming process.

True mixed prairie vegetation prevailed in Phelps County until farming became established. In those areas that are not cultivated now, tall grasses flourish during cycles of above-normal rainfall and short grasses become dominant when rainfall is scant. Grasses that cover the soil reduce or eliminate erosion and increase the intake of water by the soil. When plants decay, they supply organic matter, promote granulation, and leave root channels that increase aeration and drainage. Trees and other herbaceous plants were of little importance in the formation and development of the soils in Phelps County. No trees were growing on the bottom lands along the Platte River when the soils were forming.

Micro-organisms such as nematodes, protozoa, and bacteria, and small animals such as millipedes, spiders, and mites, act upon the organic matter in the soil and decompose it into stable humus from which plants obtain nutrients. Earthworms, fungi, algae, moles, gophers, and insects affect the formation of soils by mixing and working the organic and mineral matter.

Man also affects the formation of soils. He determines, by the kind of management he uses, whether the soil is conserved or is lost through erosion; whether the fertility is maintained; and what kinds of vegetation are dominant. Man affects the future direction and rate of soil formation through his control of runoff and his management practices on land under cultivation.

Relief

Relief affects the formation of soils through its effect on runoff and drainage. The degree of slope, shape of the surface, and permeability of the soil determine the rate of runoff, the internal drainage, and the moisture content of the soil.

In general, Phelps County slopes downward from west to east. The highest elevations are about midway along the western border. In the southwestern and northwestern parts of the county, erosion has produced local relief of as much as 50 feet. Runoff is rapid on the steep slopes, and little water is retained by the soil. Soil development is weak because soil is removed almost as fast as it is formed. Coly is the main soil in this area.

Slopes are nearly level to gently sloping in the central loess uplands. Surface runoff is slow to medium, and the soils are well developed and more mature than those on the steep slopes. Small differences in relief have caused major differences in soil development in this part of the county. Holdrege, Detroit, Crete, and Butler soils are in this area.

Depressions generally lack drainage and collect runoff from surrounding soils. In Phelps County the soils in depressions have a well-formed clayey B horizon. Soils of the Scott series and the depressional soil of the Butler series are the major soils in the well-defined depressions and in the shallow depressions, respectively.

Soils on bottom lands are affected more by internal drainage than by relief. Where the water table is high, the soil is somewhat poorly or poorly drained and the native vegetation is limited to water-tolerant grasses. Soils of the Wann, Platte, and Leshara series are the main soils on wet bottom lands. Where the water table is lower, the soil is well drained. Soils of the Cass and Grigston series are the main soils on well-drained bottom lands.

The coarse-textured to medium-textured eolian sediments in the northeastern part of the county are hummocky. The maximum relief is about 15 feet. Moisture moves readily through these soils. In the more sloping areas, surface runoff has created a complex drainage pattern characterized by many short tributaries. Valentine and Anselmo soils and the Kenesaw and Coly silt loams, hummocky, are the principal soils having hummocky relief.

Time

Time is needed for the active agents of soil development to form soils from parent material. Some soils form rapidly and others slowly. The length of time for a particular soil to form depends on the other factors involved. The oldest soils in Phelps County date back to middle or late Wisconsin time. Soils of the Butler, Crete, Detroit, and Holdrege series are old and have well-developed genetic horizons. Soil materials in which they formed have been in place long enough for climate, plant and animal life, and relief to alter the parent material. Younger loess and alluvial deposits are Mankato to Recent in age. Soils of the Kenesaw, Valentine, and Wann series formed in these parent materials and have weakly developed horizons.

A comparison of young and mature soils shows the effect of time on soil development. Young alluvial soils on bottom land lack the B horizon evident in soils that formed in older deposits. Soils formed in loess of Recent age have a lighter colored, thinner A horizon and a weaker B horizon than corresponding horizons in soils on similar topography

where the loess is of Peorian age. In general, lime is nearer the surface in young soils than in older soils.

In some instances a soil-forming factor other than time has more effect on soil characteristics. For example, Coly soils formed on steep slopes and are poorly developed, in spite of having formed in material as old as that in which the more nearly level Butler soils formed.

Classification of the Soils

Soils are classified so that we can more easily distinguish their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. Through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

In a classification system, soils are placed in broad categories to facilitate study and comparison in large areas, such as countries and continents. These broad categories are divided and subdivided into narrower classes that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways.

The system of classification now used was adopted by the National Cooperative Soil Survey in 1965. The current system is under continual study, and readers interested in the latest developments of the system should refer to the available literature (2, 4).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable or measurable. The properties are chosen, however, so that the soils of similar origin are grouped together. The classes of the current system are briefly defined in the following paragraphs:

ORDER.--Ten soil orders are recognized. They are the Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties that differentiate these orders are those that give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different climates. In Phelps County, the only soil orders are the Entisols and the Mollisols.

Entisols are recent mineral soils that do not have natural genetic horizons or that have only the beginnings of such horizons. These light-colored soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

SUBORDER.--Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest genetic similarity. A suborder has a narrower climatic range than an order. The soil properties used to separate suborders are mainly those that reflect the presence or absence of waterlogging or that reflect differences in climate or vegetation.

GREAT GROUP.--Suborders are divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those in which a pan interferes with the growth of roots or movement of water. Among features considered are the self-mulching properties of clays, the soil temperature, and major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium).

SUBGROUP.--Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups are also made in instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY.--Families are distinguished within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.--The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for the texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, consistence, reaction, and mineralogical and chemical composition.

Table 8 shows the classification of each soil series of Phelps County by family, subgroup, and order, according to the current system. The great group is not shown separately in this table because the last word in the subgroup is the name of the great group. Placement of some soil series in the current system of classification, particularly in series, may change as more precise information becomes available.

TABLE 8.--SOIL SERIES CLASSIFIED ACCORDING TO THE CURRENT SYSTEM OF CLASSIFICATION 1/

Series	Family	Subgroup	Order
Anselmo-------	Coarse-loamy, mixed, mesic-----------	Typic Haplustolls------------------	Mollisols.
Butler--------	Fine, montmorillonitic, mesic--------	Abruptic Argiaquolls---------------	Mollisols.
Cass----------	Coarse-loamy, mixed, mesic-----------	Fluventic Haplustolls--------------	Mollisols.
Coly----------	Fine-silty, mixed, calcareous, mesic--	Typic Ustorthents------------------	Entisols.
Cozad---------	Fine-silty, mixed, mesic-------------	Typic Haplustolls------------------	Mollisols.
Crete---------	Fine, montmorillonitic, mesic--------	Pachic Argiustolls-----------------	Mollisols.
Detroit-------	Fine, montmorillonitic, mesic--------	Pachic Argiustolls-----------------	Mollisols.
Grigston------	Fine-silty, mixed, mesic-------------	Fluventic Haplustolls--------------	Mollisols.
Hobbs---------	Fine-silty, mixed, mesic-------------	Cumulic Haplustolls----------------	Mollisols.
Holdrege------	Fine-silty, mixed, mesic-------------	Typic Argiustolls------------------	Mollisols.
Hord----------	Fine-silty, mixed, mesic-------------	Pachic Haplustolls-----------------	Mollisols.
Kenesaw-------	Coarse-silty, mixed, mesic-----------	Typic Haplustolls------------------	Mollisols.
Leshara-------	Fine-silty, mixed, mesic-------------	Typic Haplaquolls------------------	Mollisols.
Meadin--------	Sandy-skeletal, mixed, mesic---------	Udorthentic Haplustolls------------	Mollisols.
O'Neill-------	Coarse-loamy, mixed, mesic-----------	Typic Haplustolls------------------	Mollisols.
Platte--------	Sandy, mixed, mesic------------------	Mollic Fluvaquents-----------------	Entisols.
Rusco---------	Fine-silty, mixed, mesic-------------	Aquic Argiustolls------------------	Mollisols.
Scott---------	Fine, montmorillonitic, mesic--------	Typic Argialbolls------------------	Mollisols.
Thurman-------	Sandy, mixed, mesic------------------	Udorthentic Haplustolls------------	Mollisols.
Valentine-----	Mixed, mesic-------------------------	Typic Ustipsamments----------------	Entisols.
Wann 2/-------	Coarse-loamy, mixed, mesic-----------	Fluvaquentic Haplustolls-----------	Mollisols.

1/ Classification as of April, 1972.

2/ Wann soil in the Platte-Wann complex is only 20 to 40 inches deep over mixed sand and gravel. This depth is outside the range of the series as presently described.

Mechanical and Chemical Analyses

Two profiles of Holdrege silt loam were collected from Phelps County for mechanical and chemical analysis. The analyses were made by the Soil Conservation Service in its laboratory at Lincoln, Neb. Data for these profiles are given in "Soil Survey Investigations Report No. 5" (6). Anselmo, Cass, Crete, Hord, Kenesaw, Leshara, Thurman, Valentine, and Wann soils have been sampled in nearby counties, and useful data for these profiles are also given in report No. 5.

Data from mechanical and chemical analyses are useful to soil scientists in classifying soils and in developing concepts of soil genesis. This information is also helpful in estimating available water capacity, susceptibility to soil blowing, fertility, tilth, and other soil characteristics that affect management. Data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali areas.

GENERAL NATURE OF THE COUNTY

This section gives information on the early history and population, climate, physiography, relief, drainage, transportation, industry, agricultural statistics and trends, natural resources, and cultural facilities of Phelps County.

Early History and Population

Before the arrival of the white man, Phelps County afforded grazing for buffalo, deer, and other animals. Pawnee indians inhabited the area.

Shortly after the Civil War, pioneers came to the area to secure homesteads. The Homestead Act was passed by Congress on May 20, 1862, and became effective in Nebraska on January 1, 1863. The first claims were staked in the northern part of the county and along Spring Creek in the southwestern part.

Upon the approval of Governor Furnas, the boundaries of Phelps County were established on February 11, 1873. By 1879, most of the land was homesteaded and the county had two sizable villages, Phelps Center and Sacramento. The small towns of

Funk, Atlanta, Loomis, and Bertrand were laid out in the middle 1880's. Ground was donated in Phelps Center for a courthouse site. In 1879 the frame courthouse was moved from Williamsburg Township across the county to Phelps Center. The county government continued there until a special vote on November 11, 1884, provided for a move of the county records to Holdrege on November 26, 1884. The establishment of Holdrege was precipitated by a need for rail service to market the produce of the area; the Chicago, Burlington, and Quincy Railroad built its cutoff line from Kenesaw through Holdrege to Oxford.

The population of Phelps County rose steadily until 1900, and then declined until 1940. Census figures indicate a county population of 2,447 in 1890; 10,772 in 1900; 8,448 in 1940; and 9,800 in 1960. The increase from 1940 to 1960 resulted mainly from growth of Holdrege and some of the surrounding smaller towns.

Climate 7/

Phelps County has a continental climate characterized by relatively warm summers, cold winters, and variable rainfall.

Because the county is between the rain shadow of the Rocky Mountains and the more humid regions to the east, the amount of precipitation varies considerably from year to year in response to small changes in the prevailing winds. Nearly all moisture that falls in this area is carried in on warm winds from the Gulf of Mexico and the Caribbean. Drought conditions develop when these currents maintain a more easterly position. The average precipitation during the 10 wettest years of record is more than 2 1/2 times that received during the 10 driest years of record.

Generally, more than three-fourths of the annual precipitation falls during the months of April through September. Precipitation early in spring is slow, steady, and well distributed. As spring advances more and more of the moisture falls during erratic thundershowers and, by the latter part of May, nearly all the precipitation comes in this manner. Local droughts occur when showers are poorly spaced in either time or location. These droughts can damage the corn crop if they come at a critical stage in its growth. This hazard has been practically eliminated, however, in those areas where natural rainfall is supplemented by irrigation. Except for occasional droughts, the climate is well suited to grain farming and to the raising of livestock.

In spring and early summer, some thunderstorms are accompanied by local downpours, hail, and damaging winds. Damage to crops by local hailstorms is often severe, but the affected area is generally a strip a half mile to a mile wide and a few miles in length. Hailstorms in June and early July do more damage to wheat than to other crops, because the wheat has headed and is filling at this time. Storms that occur early in summer can strip the leaves from corn, sometimes nearly to the bare stalk. If the storm is followed by favorable weather, however, young corn plants make remarkable recovery. Hailstorms are less frequent after the middle of July, but those that do occur inflict a greater amount of permanent damage on the corn.

In the fall, showers become lighter and farther apart. The average monthly precipitation is 2.13 inches in September, 1.17 inches in October, and only 0.71 inch in November (table 9). The dry weather, combined with an abundance of sunshine, is favorable to maturing of crops and aids in their harvest. An exceptionally dry fall can result in the ears of corn falling from their stalks, and in the slow germination and growth of winter wheat. In most years, however, moisture is sufficient for wheat to make suitable growth before winter sets in.

Winter precipitation is generally light. Most of it falls as snow, though an occasional period of freezing rain can occur if cold air near the ground is overrun by warm, moist, southerly winds. The snow often arrives with sharply falling temperatures and strong northerly winds that cause considerable drifting. Snow cover ordinarily remains only a short time, and the ground frequently becomes bare before additional snow arrives. During periods of little or no snow cover, cattle can obtain much of their food from cured pasture grass, cornstalks in fields, and sorghum stubble. Sometimes winter wheat grows enough to be pastured, particularly during the beginning of and again at the end of the winter season. By the latter part of March, most of the precipitation falls as rain, although heavy snows occasionally occur in April, and light snows in May.

The absence of climatological barriers to the north and south permits rather large and frequent fluctuations in temperature during winter as the wind shifts from southerly to northerly, or reverse. Sharp temperature changes continue into early spring and then gradually decrease in severity and number as the ground to the north becomes warm and is no longer a source of cold air. The summer heat is occasionally broken by cool spells lasting several days following the invasion of mild air from the Pacific Ocean.

The temperature failed to go below 0° F. in only two winters out of 66 seasons on record. During most winters, the lowest temperature has ranged from -7° to -15°. The highest temperature during each of the winter months generally has ranged from the upper 50's to the 60's. Readings in the 70's are rare in December and January but are not unusual by the end of February.

Spring temperatures vary considerably. In March, it has been as cold as -12° and as high as 92°. In May, the absolute range has been from a low of 19° to a high of 103°. The average date of the last freeze in spring is after April 28th (table 10), but the last freeze in spring has occurred as early as April 7th and as late as May 29th. Summer temperatures

7/ By RICHARD E. MYERS, State climatologist, National Weather Service.

TABLE 9.--TEMPERATURE AND PRECIPITATION

[All data for Holdrege. Precipitation probabilities based on period 1890-1962; all other data based on period 1933-62]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Two years in 10 will have at least 4 days with--: Maximum temperature equal to or higher than-	Temperature: Two years in 10 will have at least 4 days with--: Minimum temperature equal to or lower than--	Precipitation: Average monthly total	Precipitation: One year in 10 will have--: Equal to or less than--	Precipitation: One year in 10 will have--: Equal to or more than--	Precipitation: Days having snow cover of 1 inch or more	Precipitation: Average depth of snow on days having snow cover
	° F.	° F.	° F.	° F.	Inches	Inches	Inches		Inches
January----	37.1	15.4	57	-5	0.56	0.03	1.05	11	4.3
February---	41.3	19.1	62	1	.76	.20	1.61	10	3.2
March------	51.4	26.5	73	8	1.34	.20	2.55	6	4.9
April------	64.9	38.4	83	25	2.34	.39	5.84	1	2.5
May--------	74.8	49.4	91	37	4.17	.92	6.99	0	---
June-------	85.4	59.6	101	48	4.22	1.06	7.68	0	---
July-------	92.7	65.2	105	57	2.57	.89	4.71	0	---
August-----	91.1	64.1	104	54	2.49	.95	5.45	0	---
September--	81.4	53.8	97	40	2.13	.40	4.13	0	---
October----	69.0	42.6	84	29	1.17	.10	3.50	0	---
November---	50.8	28.2	67	14	.71	(3/)	2.02	3	2.7
December---	40.4	20.3	57	4	.60	.02	1.22	8	3.3
Year-----	65.0	40.2	1/ 106	2/ -11	23.06	16.10	32.79	38	3.8

1/ Average annual highest maximum.

2/ Average annual lowest minimum.

3/ Trace.

TABLE 10.--PROBABILITIES OF SPECIFIED TEMPERATURES IN SPRING AND FALL

[All data for Holdrege]

Probability	Date for given probability and temperature: 16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10 later than-------	Apr. 5	Apr. 13	Apr. 20	May 2	May 14
2 years in 10 later than------	Mar. 30	Apr. 8	Apr. 15	Apr. 26	May 8
5 years in 10 later than------	Mar. 20	Mar. 28	Apr. 4	Apr. 15	Apr. 28
Fall:					
1 year in 10 earlier than-----	Nov. 2	Oct. 24	Oct. 18	Oct. 9	Sept. 28
2 years in 10 earlier than----	Nov. 7	Oct. 29	Oct. 24	Oct. 14	Oct. 4
5 years in 10 earlier than----	Nov. 16	Nov. 8	Nov. 3	Oct. 24	Oct. 15

show less variability. In 8 to 9 years out of 10, the highest temperature in each of the summer months has ranged from 95° to 109°. The lowest temperature during June has ranged from 40° to 54°; and in July and August, from 45° to 59°. In about 1 year in 12, the temperature fails to reach 100° during the entire summer.

Warm daytimes continue well into September, but nighttime temperatures drop off rapidly. Readings in the 40's have been recorded in all Septembers, and in two-thirds of the years temperatures were into the 30's at some time before the end of September. The average date of the first freeze in the fall is October 15th (table 10), but the first freeze has occurred as early as September 20th and as late as November 5th.

The prevailing wind is from the south to the southeast from May through October, and from the north to the northwest for the rest of the year. Its average yearly speed is approximately 11 miles per hour. In spring, the windiest season, the average wind velocity is 12 to 13 miles per hour. Daily average wind speed reaches 20 miles per hour or more about 8 days during the season, often for 2 or 3 days at a time. Winter winds have the lowest average speed, but, at times, strong northerly winds of 20 miles per hour or more occur. Strong winds occur infrequently during summer and fall. The highest wind velocities, which are sometimes damaging, accompany severe thunderstorms and are of short duration.

The monthly amounts of potential evapotranspiration, computed by the Thornthwaite method using mean temperatures from Holdrege for the period from 1933 to 1962, are given below. No figures are supplied for January, February, or December, when the mean temperatures are below 32° F.

Month	Inches	Month	Inches
March----------	0.44	August-------	6.02
April----------	1.76	September----	3.77
May------------	3.50	October------	1.95
June-----------	5.31	November-----	.30
July-----------	6.73		

Physiography, Relief, and Drainage

Phelps County iis part of a large, ancient, upland plain. The area was mantled by sand and gravel when glaciers occupied the eastern part of the State. Later, several layers of loess covered the county to depths of as much as 50 feet.

The most recent loess, in the northeastern part of the county, is hummocky. Small drains wind about the hummocks and eventually find their way to larger, more deeply incised drains that lead to the Platte River. In the southwestern and northwestern parts of the county, geologic erosion created canyon areas where the difference in relief reaches as much as 50 feet. Drainage patterns in the southern part of the county are in a southerly direction to the Republican River. In the northern part, drainage is northerly to the Platte River.

The Platte River has cut its way into the landscape, and part of its valley forms a band along the northern part of the county. Some of the bottom land in this nearly level valley is crossed by old shallow channels. Some of the stream terraces were reworked by wind and are of low hummocky topography. The water table ranges from 1 to 10 feet below the bottom land along the river.

Transportation

Several hundred miles of gravel and dirt roads and about 40 miles of hard-surfaced roads are in Phelps County. U.S. Highway 183 crosses the county in a north-south direction through Holdrege. U.S. Highways 6 and 34 cross the county in a northeast-southwest direction and pass through the towns of Funk, Holdrege, and Atlanta. State Highway 23 goes northwest from Holdrege through Loomis to Bertrand and on out of the county.

The Chicago, Burlington, and Quincy Railroad generally parallels U.S. Highways 6 and 34. It serves the towns of Funk, Holdrege, and Atlanta. A spur parallel to State Highway 23 serves Loomis and Bertrand.

Three bus lines cross Phelps County. Privately chartered plane service, as well as airport landing and service for small aircraft, is available at Holdrege.

Industry

Many small industries have been established in Phelps County. Those associated with agriculture are the processing of dairy products, feed milling, and the dehydration of alfalfa. Other industrial plants manufacture soft beverages, fabric labels, and welding and electrical supplies. A granite monument business is located in Holdrege. The trend toward industrial expansion can be expected to continue because power, water, and land are readily available.

Farm Statistics and Trends

Since the county was first settled, the main interest has been farming. In the early years crop production was only for local consumption. When grain elevators and railroads made markets available, production of both crops and livestock increased. The development of farming was slow until water for irrigation was made available in 1941 by the Central Nebraska Public Power and Irrigation District. Irrigation greatly increased yields but made the application of commercial fertilizers necessary. The acreage on which commercial fertilizers were applied increased from 70,500 in 1957 to 85,400 in 1963. In the year from July 1, 1962, to June 30, 1963, 10,648 tons of fertilizer were sold in Phelps

County. Irrigated land in the county increased from 44,800 acres in 1945 to 88,600 acres in 1963.

Corn is the main crop in the county. Although the trend in the total acreage is downward, 75,000 acres was grown in 1963. Wheat is the next most important crop. The trend is likewise downward, and the acreage was 46,750 in 1963. A total of 32,900 acres of grain sorghum was grown in 1963, and the trend is upward. The only other major crop is alfalfa, and its acreage is increasing. Minor crops are oats, sugar beets, rye, soybeans, and barley.

Ranching is a fairly important agricultural enterprise. Many beef cattle are raised, fed, and marketed. In 1963, there were 29,000 cattle in feedlots, nearly 1,500 dairy cattle, and about 3,000 sheep. The number of cattle in feedlots is increasing because of the commercial feeders. The number of dairy cattle remains about the same. Sheep and swine feeding and marketing contribute a sizable amount to the total income of the county. Most farmers have some chickens.

The number of farms in Phelps County decreased from 995 in 1956 to 840 in 1963. This decrease reflects the trend toward larger farming units. According to the 1959 U.S. Census of Agriculture, about 28 percent of the farms in the county are operated by owners, 41 percent by tenants, and 31 percent by part owners, managers, or others.

Most farms are equipped with the modern conveniences of the nearby towns. Electric power, hot and cold running water, and telephone service are common. Telephone lines are usually owned by individual groups of farmers.

Natural Resources

Soil and water are important natural resources in Phelps County. The soils are suited to a wide variety of crops and other agricultural enterprises. The friable soils are well suited to irrigation. The topography is well suited to gravity irrigation systems after some land leveling has been done. Irrigation water delivered through canals that are owned and operated by the Central Nebraska Public Power and Irrigation District is available in the northern half of the county. Water of good quality is available from wells in most places. Several sand pits on the flood plain of the Platte River provide sand and gravel for road building and improvements.

Cultural Facilities

Phelps County presently has fourteen school districts. Recent consolidation, relocation, and building of new rural schools are resulted in better facilities for grade school children in rural areas. Loomis, Bertrand, and Holdrege each have a high school.

Each town has several churches, and there are six country churches. The dominant faith is Protestant.

Holdrege, the county seat and largest town, has a library, bowling alley, golf course, swimming pool, a large park, and indoor and drive-in movie theaters. Facilities for boating, water skiing, swimming, and picnicking are available at Johnson Lake, about 30 miles northwest of Holdrege, and at Harlan County Lake, 24 miles south of Holdrege.

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Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil that has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Amendment. Any material, such as lime, gypsum, sawdust, or synthetic conditioner, that is worked into the soil to make it more productive. A fertilizer is also an amendment, but the term "amendment" is used most commonly for material other than fertilizer that is added to the soil.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. In this survey, the classes of available water capacity for a 60-inch profile, or to a limiting layer, are:

Very low	0 to 3 inches
Low	3 to 6 inches
Moderate	6 to 9 inches
High	more than 9 inches

Bench leveling. The building of shelflike embankments of earth that have a level or nearly level top and a steep or nearly vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the embankments may be made of rocks or masonry, or it may be planted to vegetation.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Catch crop. A crop grown between two crops in ordinary sequence or between the rows of a main crop, or as a substitute for a staple crop that has failed.

Catsteps. Narrow steps on moderately steep and steep hillsides, produced by slumping or soil slippage.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are--

<u>Loose</u>.--Noncoherent when dry or moist; does not hold ttogether in a mass.

<u>Friable</u>.--When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

<u>Firm</u>.--When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

<u>Plastic</u>.--When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

<u>Sticky</u>.--When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

<u>Hard</u>.--When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

<u>Soft</u>.--When dry, breaks into powder or individual grains under very slight pressure.

<u>Cemented</u>.--Hard and brittle; little affected by moistening.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Deciduous. Refers to plants that lose their leaves maturity, or at certain seasons. Contrasts with evergreen.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Dispersion, soil. Deflocculation of the soil and its suspension in water.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottlings below a depth of 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Dugout. An open pit excavated below the ground surface to intercept and store surface or ground water.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, pitting basin listing, or other means to roughen the soil surface for temporary control of wind erosion.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Evergreen (botany). A plant or tree that remains verdant, such as conifer trees and many tropical plants. Evergreen is often used loosely as a synonym for conifer, but some conifers, such as the larch, are deciduous, and many evergreens, such as the laurel, are not conifers. Contrasts with deciduous.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called normal field capacity, normal moisture capacity, or capillary capacity.

Fine-textured soils. Moderately fine textured: clay loam, sandy clay loam, silty clay loam; Fine-textured: sandy clay, silty clay, and clay. Roughly, soil that contains 35 percent or more of clay.

Forage. Plant material that can be used as feed by animals; it may be grazed or cut for hay.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, and covered by grass for protection against erosion; used to conduct surface water away from cropland.

Gravelly soil material. From 15 to 50 percent of material, by volume, consists of rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Green manure. A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvements.

Gypsum. Calcium sulfate.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.--The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.--The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.--The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.--The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.--Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Hummocky. Characterized by rounded knolls or hillocks.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by height of the water table, either permanent or perched. Relative terms for expressing internal drainage are none, very slow, slow, medium, rapid, and very rapid.

Land leveling. The reshaping of the ground surface to make for a more uniform application of irrigation water.

Landscape. All the characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern, in contrast to other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Legume. A member of the legume or pulse family (Leguminosae). One of the most important and widely distributed plant families. Includes many valuable forage species, such as peas, beans, peanuts, alfalfa, sweet clover, lespedeza, vetch, and kudzu. Practically all legumes are nitrogen-fixing plants, and many of the herbaceous species are used as cover and green-manure crops. Even some of the legumes that have no forage value (crotalaria and some lupines) are used for soil improvement. Other legumes are locust, honeylocust, redbud, mimosa, wisteria, and many tropical plants

Length-of-run (irrigation). The distance water is carried in furrows or by flooding from the head ditch to the lower end of the field.

Level terrace. A terrace that follows the absolute contour, as contrasted with a graded terrace. Used only on permeable soils where conservation of moisture for crops is particularly important or where outlet channels are not practical.

Light soil. A term used for sandy, or coarse-textured, soil.

Lime. Chemically, lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soils. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Loam. A soil consisting of a friable mixture of varying proportions of clay, sand, and organic matter.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Mature soil. Any soil with well-developed soil horizons having characteristics produced by the natural processes of soil formation and in near equilibrium with its present environment.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance--few, common, and many; size--fine, medium, and coarse; and contrast--faint, distinct, and prominent. The size measurements are these: fine, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Mulch. A natural or artificially applied layer of plant residue or other material on the surface of the soil. Mulches are generally used to help conserve moisture, control temperature, prevent surface compaction or crusting, reduce runoff and erosion, improve soil structure, or control weeds. Common mulching materials are wood chips, plant residue, sawdust, and compost.

Munsell notation. A system for designating color by degrees of the three simple variables--hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Neutral soil. In practice, a soil having a pH value between 6.6 and 7.3. Strictly speaking, a soil that has a pH value of 7.0.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil, and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a moist soil that enables water or air to move through it. In this survey, permeability applies to that part of the soil below the Ap or equivalent layer and above a depth of 60 inches, or to a lithic or paralithic contract that occurs at a shallower depth. Where there are two or more permeability classes within a short vertical distance, the classes and depths are stated. Classes of soil permeability in inches of water per hour are as follows:

Very slow	Less than 0.063
Slow	0.063 to 0.20
Moderately slow	0.20 to 0.63
Moderate	0.63 to 2.00
Moderately rapid	2.00 to 6.30
Rapid	6.30 to 20.0
Very rapid	20.0 and over

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management, but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Piping. Subsurface passageways or pipes caused by dislodging and transporting of soil particles by uncontrolled flowing water. Process occurs in only some kinds of soils but can lead to failure of a hydraulic structure.

Plastic (soil consistence). Capable of being deformed without being broken.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land on which there are some forest trees.

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are--excellent, good, fair, and poor. The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour" soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rotation grazing. Grazing two or more pastures, or parts of a range, in regular order, with definite recovery periods between grazing periods. Contrasts with continuous grazing.

Row crop. A crop planted in rows, generally 2 to 4 feet apart, so as to allow cultivation between rows during the growing season.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Salts. Products, other than water, that result when an acid reacts with a base. Salts commonly found in soils break up into cations (sodium, calcium, and so on) and anions (chloride, sulfate, and so on) when dissolved in water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sandy soil. A broad term for soils of the sand and loamy sand classes; soil material with more than 70 percent sand and less than 15 percent clay.

Shrink-swell potential (engineering). Amount that a soil will expand when wet or contract when dry. Indicates kinds of clay in soil.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium or alkali.

Slope. The degree of deviation of a surface from the horizontal, usually expressed in percent or degrees. In this survey the following slope classes are recognized:

Nearly level	0 to 1 percent
Very gently sloping or very gently undulating	1 to 3 percent
Gently sloping or gently rolling	3 to 7 percent
Moderately sloping or undulating	7 to 10 percent
Strongly sloping or rolling	10 to 17 percent
Moderately steep or hilly to steep	17 to 30 percent
Very steep	More than 30 percent

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are--platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grain (each grain by itself, as in dune sand) or massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble. The basal part of plants that remains after the top has been harvested; also the part of grasses that remains after current grazing is completed.

Subgrade (engineering). The substratum, consisting of in-place material or fill material, that is prepared for highway construction; does not include stabilized base course or actual paving material.

Subsoil. In this survey, the B horizon; generally, the part of the solum below plow depth.

Subsurface layer. In this survey, the A2 horizon of a soil; generally, the layer immediately below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting of winter grains.

Surface layer. In this survey, the Ap and A1 horizons of the soil; generally, the layer at the surface, regardless of its thickness.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A

soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Underlying material. In this survey, the C horizon of a soil; generally, weathered soil material immediately beneath the solum.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

V-ditches. Drainage ditches that are V-shaped and have smooth side slopes.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Windbreak. Any shelter that protects from the wind. A vegetative windbreak is a strip of closely spaced trees or shrubs that is planted primarily to deflect wind currents and thereby reduce soil blowing, control snow drifting, conserve moisture, and protect crops, livestock, and buildings.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of prevailing wind and without strict adherence to the contour of the land.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. For facts about wildlife and recreation, turn to the section beginning on p. 55 . Other information is given in tables as follows:

Acreage and extent, table 1, page 11.
Predicted yields, table 2, page 47.
Engineering uses of the soils, tables 5, 6, and 7, pages 58 through 75.

Map symbol		Described on page	Capability unit Dryland Symbol	Page	Irrigated Symbol	Page	Range site Name	Page	Windbreak suitability group Name	Page
Ag	Anselmo very fine sandy loam, 0 to 1 percent slopes	13	IIc-1	37	I-2	37	Sandy	51	Silty to Clayey	54
2Ag	Anselmo very fine sandy loam, terrace, 0 to 1 percent slopes	13	IIc-1	37	I-2	37	Sandy	51	Silty to Clayey	54
AnA	Anselmo fine sandy loam, 0 to 3 percent slopes	12	IIe-3	38	IIe-3	38	Sandy	51	Sandy	54
2AnA	Anselmo fine sandy loam, terrace, 0 to 3 percent slopes	12	IIe-3	38	IIe-3	38	Sandy	51	Sandy	54
AnB	Anselmo fine sandy loam, hummocky	12	IIIe-3	41	IIIe-3	41	Sandy	51	Sandy	54
AnB2	Anselmo fine sandy loam, hummocky, eroded	12	IIIe-3	41	IIIe-3	41	Sandy	51	Sandy	54
AnC	Anselmo fine sandy loam, 7 to 10 percent slopes	12	IVe-3	42	IVe-3	42	Sandy	51	Sandy	54
Bu	Butler silt loam	14	IIs-2	38	IIs-2	38	Clayey	51	Silty to Clayey	54
2Bu	Butler silt loam, depressional	14	IIIw-2	41	IIs-21	41	Clayey Overflow	50	Moderately Wet	54
CbD	Coly silt loam, 10 to 30 percent slopes	15	VIe-9	45	---------	--	Limy Upland	51	Silty to Clayey	54
Ce	Crete silt loam	17	IIs-2	38	IIs-2	38	Clayey	51	Silty to Clayey	54
CKC	Coly and Kenesaw silt loams, 7 to 10 percent slopes	16								
	Coly part	--	IVe-9	43	IVe-12	43	Limy Upland	51	Silty to Clayey	54
	Kenesaw part	--	IVe-9	43	IVe-12	43	Silty	51	Silty to Clayey	54
Coz	Cozad silt loam	16	IIc-1	37	I-2	37	Silty Lowland	51	Silty to Clayey	54
Cs	Cass fine sandy loam	15	IIe-3	38	IIe-3	38	Sandy Lowland	50	Sandy	54
De	Detroit silt loam	18	IIc-1	37	I-2	37	Silty	51	Silty to Clayey	54
Gp	Grigston silt loam	19	I-1	36	I-1	36	Silty Lowland	51	Silty to Clayey	54
Hb	Hobbs silt loam	20	IIw-31	39	IIw-3	39	Silty Overflow	50	Moderately Wet	54
2Hb	Hobbs silt loam, overwash	20	IIc-1	37	I-2	37	Silty Lowland	51	Silty to Clayey	54
HCC2	Holdrege-Coly complex, 7 to 10 percent slopes, eroded	22								
	Holdrege part	--	IVe-8	43	IVe-11	43	Silty	51	Silty to Clayey	54
	Coly part	--	IVe-8	43	IVe-11	43	Limy Upland	51	Silty to Clayey	54
Hd	Hord silt loam	23	IIc-1	37	I-2	37	Silty	51	Silty to Clayey	54
2Hd	Hord silt loam, terrace	23	IIc-1	37	I-2	37	Silty Lowland	51	Silty to Clayey	54
Ho	Holdrege silt loam, 0 to 1 percent slopes	21	IIc-1	37	I-2	37	Silty	51	Silty to Clayey	54
HoA	Holdrege silt loam, 1 to 3 percent slopes	21	IIe-1	37	IIe-1	37	Silty	51	Silty to Clayey	54
HoA2	Holdrege silt loam, 1 to 3 percent slopes, eroded	21	IIe-1	37	IIe-1	37	Silty	51	Silty to Clayey	54

Map symbol		Described on page	Capability unit Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page	Windbreak suitability group Name	Windbreak suitability group Page
HoB	Holdrege silt loam, 3 to 7 percent slopes---------------	21	IIIe-1	40	IIIe-1	40	Silty	51	Silty to Clayey	54
HoB2	Holdrege silt loam, 3 to 7 percent slopes, eroded-------	21	IIIe-1	40	IIIe-1	40	Silty	51	Silty to Clayey	54
HoC	Holdrege silt loam, 7 to 10 percent slopes---------------	21	IVe-1	42	IVe-1	42	Silty	51	Silty to Clayey	54
HwB3	Holdrege soils, 3 to 7 percent slopes, severely eroded------	22	IVe-8	43	IVe-11	43	Silty	51	Silty to Clayey	54
KCA	Kenesaw and Coly silt loams, 1 to 3 percent slopes--------	24								
	Kenesaw part---------------	--	IIIe-11	40	IIe-11	40	Silty	51	Silty to Clayey	54
	Coly part------------------	--	IIIe-11	40	IIe-11	40	Limy Upland	51	Silty to Clayey	54
2KC	Kenesaw and Coly silt loams, hummocky---------------------	24								
	Kenesaw part---------------	--	IIIe-1	40	IIIe-1	40	Silty	51	Silty to Clayey	54
	Coly part------------------	--	IIIe-1	40	IIIe-1	40	Limy Upland	51	Silty to Clayey	54
2KC2	Kenesaw and Coly silt loams, hummocky, eroded-------------	24								
	Kenesaw part---------------	--	IIIe-1	40	IIIe-1	40	Silty	51	Silty to Clayey	54
	Coly part------------------	--	IIIe-1	40	IIIe-1	40	Limy Upland	51	Silty to Clayey	54
Ks	Kenesaw silt loam, 0 to 1 percent slopes---------------	24	IIc-1	37	I-2	37	Silty	51	Silty to Clayey	54
2KsA	Kenesaw silt loam, terrace, 1 to 3 percent slopes--------	24	IIe-1	37	IIe-1	37	Silty Lowland	51	Silty to Clayey	54
Le	Leshara silt loam--------------	25	IIw-4	39	IIw-4	39	Subirrigated	50	Moderately Wet	54
2Le	Leshara silt loam, saline------	26	IVs-1	43	IIIs-1	43	Saline Subirrigated	50	Moderately Saline-alkali	54
Lx	Loamy alluvial land------------	26	VIIs-3	46	--------	--	Subirrigated	50	Undesirable	55
M	Marsh--------------------------	26	VIIIw-1	46	--------	--	------------	--	Undesirable	55
2Md	Meadin loamy sand, terrace, 0 to 2 percent slopes----------	27	VIs-41	45	--------	--	Shallow to Gravel	52	Shallow	54
2Mw	Meadin silt loam, terrace, 0 to 1 percent slopes----------	27	VIs-4	44	IVs-4	44	Shallow to Gravel	52	Shallow	54
On	O'Neill fine sandy loam, 0 to 1 percent slopes-------------	28	IIIe-3	41	IIIe-3	41	Sandy	51	Sandy	54
P	Platte soils-------------------	28	VIw-4	45	IVw-4	45	Subirrigated	50	Moderately Wet	54
2PW	Platte-Wann complex, channeled--------------------	29	VIw-4	45	IVw-4	45	Subirrigated	50	Moderately Wet	54
RB	Rough broken land, loess-------	29	VIIe-1	46	--------	--	Thin Loess	52	Undesirable	55
Ru	Rusco silt loam----------------	30	IIw-3	38	I-3	38	Silty Lowland	51	Moderately Wet	54
Sc	Scott silt loam----------------	30	IVw-2	44	--------	--	------------	--	Undesirable	55
S	Spoil banks--------------------	31	VIIIs-1	46	--------	--	------------	--	Undesirable	55
2Th	Thurman loamy fine sand, terrace, 0 to 3 percent slopes--	31	IIIe-5	41	IIIe-5	41	Sandy	51	Sandy	54
VcB	Valentine loamy sand-----------	32	VIe-5	45	--------	--	Sands	51	Very Sandy	54
Wb	Wann fine sandy loam-----------	33	IIw-6	39	IIw-6	--	Subirrigated	50	Moderately Wet	54
Wm	Wann loam----------------------	33	IIw-4	39	IIw-4	39	Subirrigated	50	Moderately Wet	54
2Wm	Wann loam, saline--------------	33	IVs-1	43	IIIs-1	43	Saline Subirrigated	50	Moderately Saline-alkaline	54

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

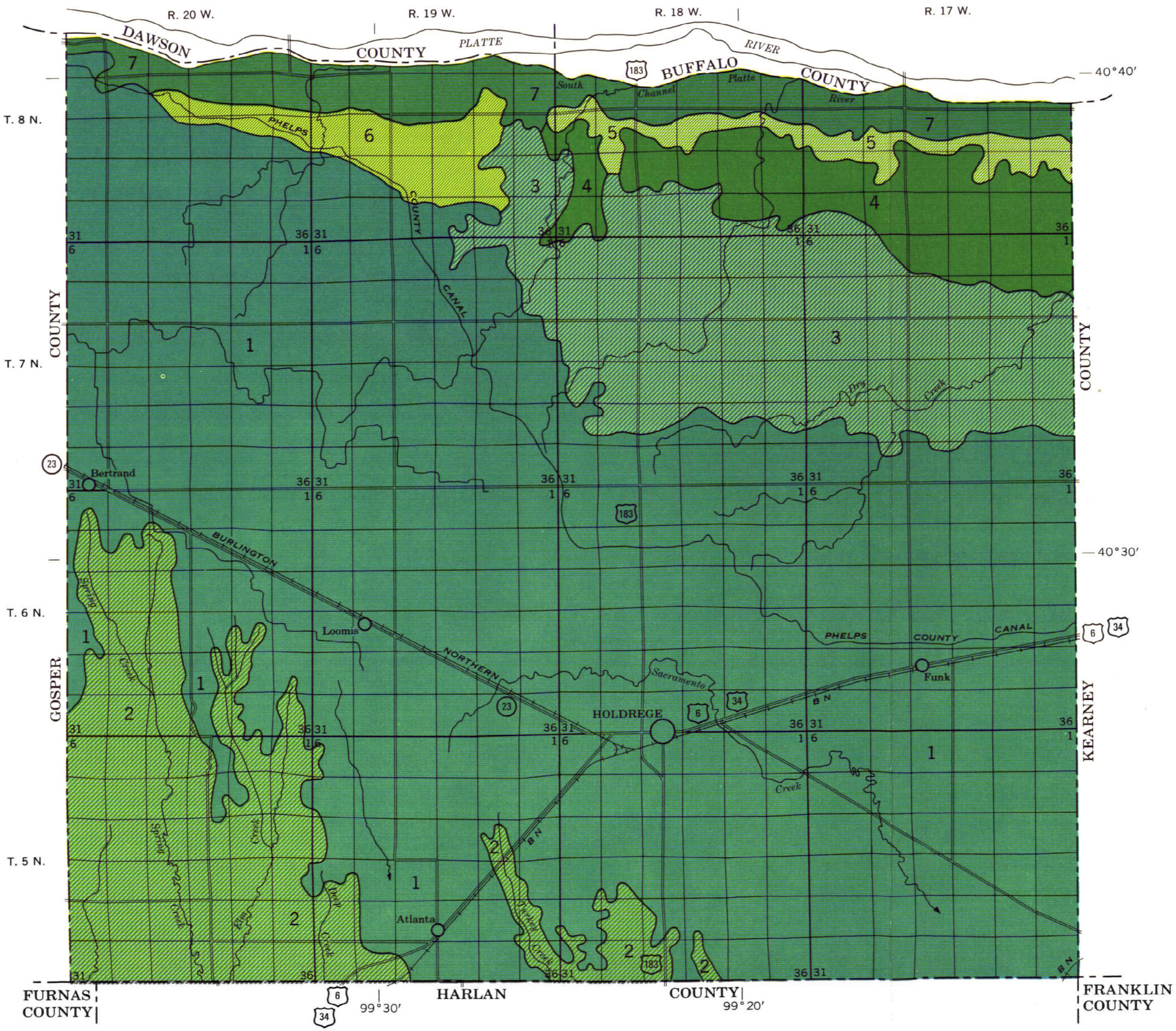
GENERAL SOIL MAP

PHELPS COUNTY, NEBRASKA

Scale 1:190 080

1 0 1 2 3 4 Miles

N



SOIL ASSOCIATIONS*

1	Holdrege association: Deep, nearly level to moderately sloping, silty soils; on uplands
2	Coly-Holdrege association: Deep, gently sloping to steep, silty soils; on uplands
3	Kenesaw-Anselmo association: Deep, nearly level to moderately sloping, loamy soils; on uplands
4	Valentine-Anselmo association: Deep, nearly level to strongly sloping, sandy and loamy soils; on uplands
5	Meadin-Anselmo-O'Neill association: Nearly level to very gently sloping, loamy and sandy soils that are shallow to deep over sand and gravel; on terraces
6	Hord association: Deep, nearly level, silty soils; on terraces
7	Leshara-Wann association: Nearly level, loamy soils that are deep and moderately deep over sand and gravel; on bottom lands

*Texture in the name of the associations refers to the surface layer of the major soils.

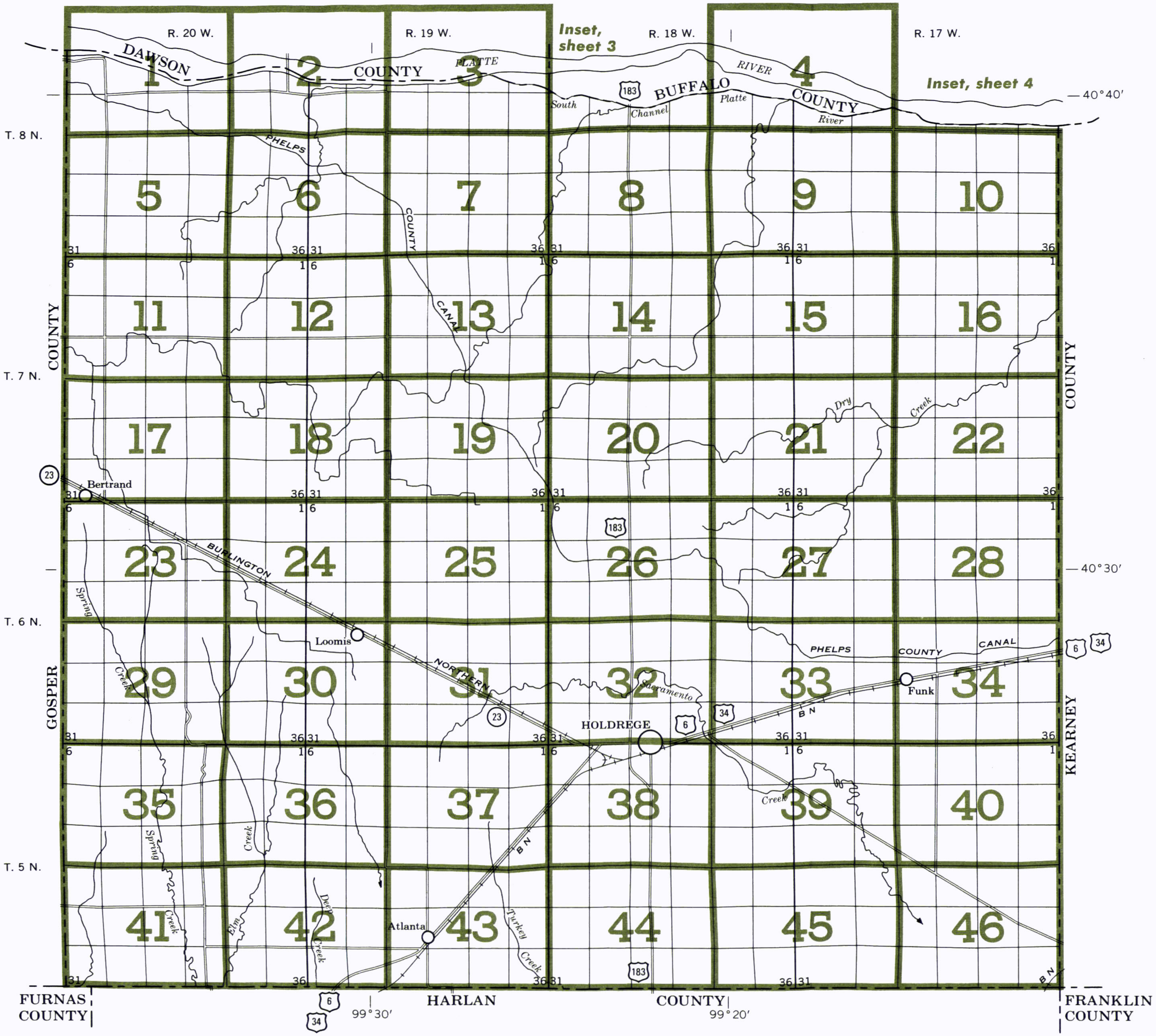
Published 1972

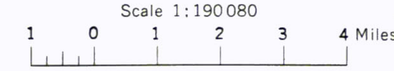
This map is for general planning. It shows only the major soils and does not contain sufficient detail for operational planning.

INDEX TO MAP SHEETS

PHELPS COUNTY, NEBRASKA

Scale 1:190 080





PHELPS COUNTY, NEBRASKA — SHEET NUMBER 1

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 1

(2)

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 2

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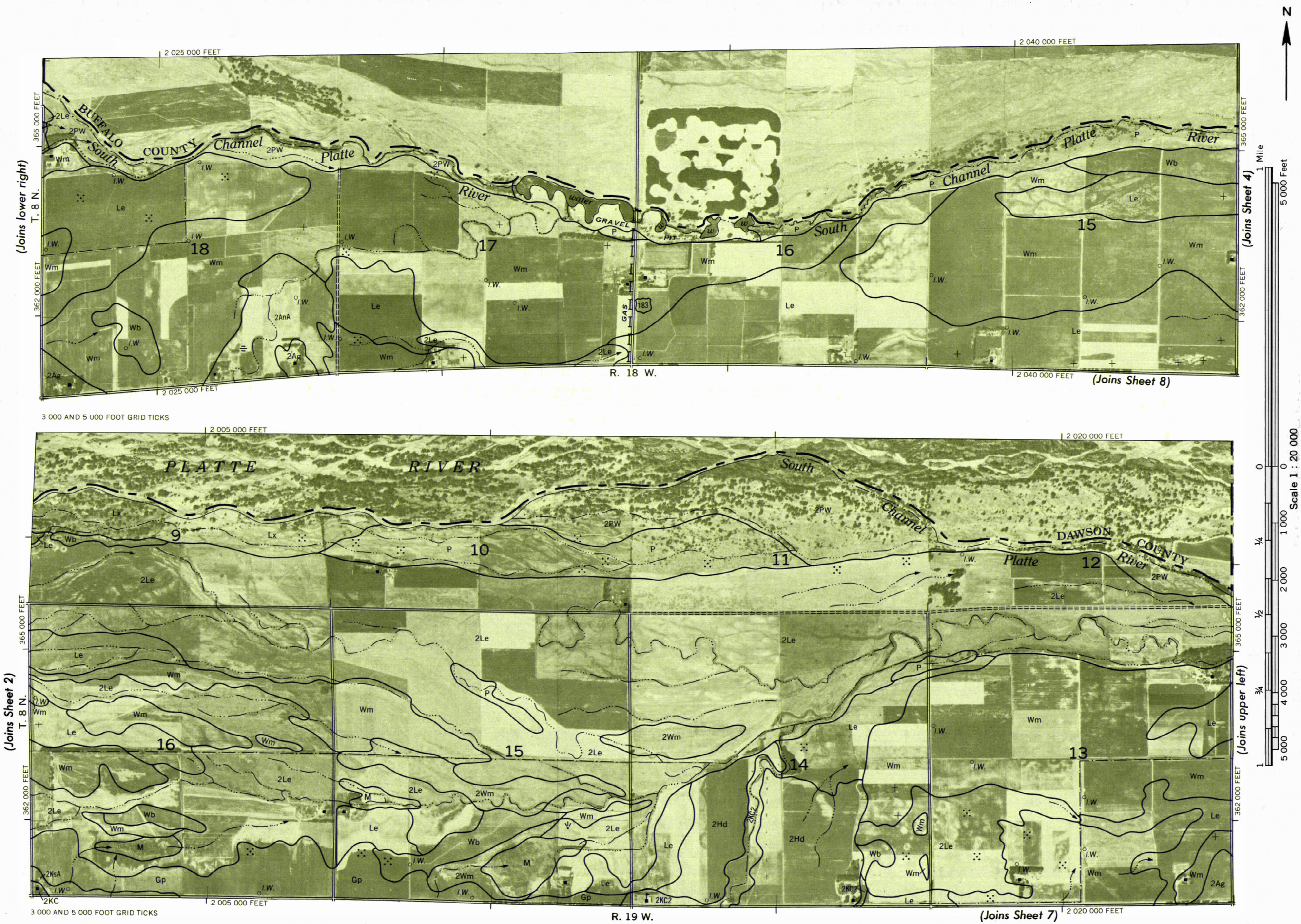

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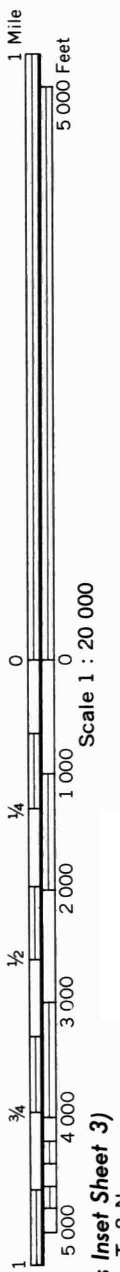

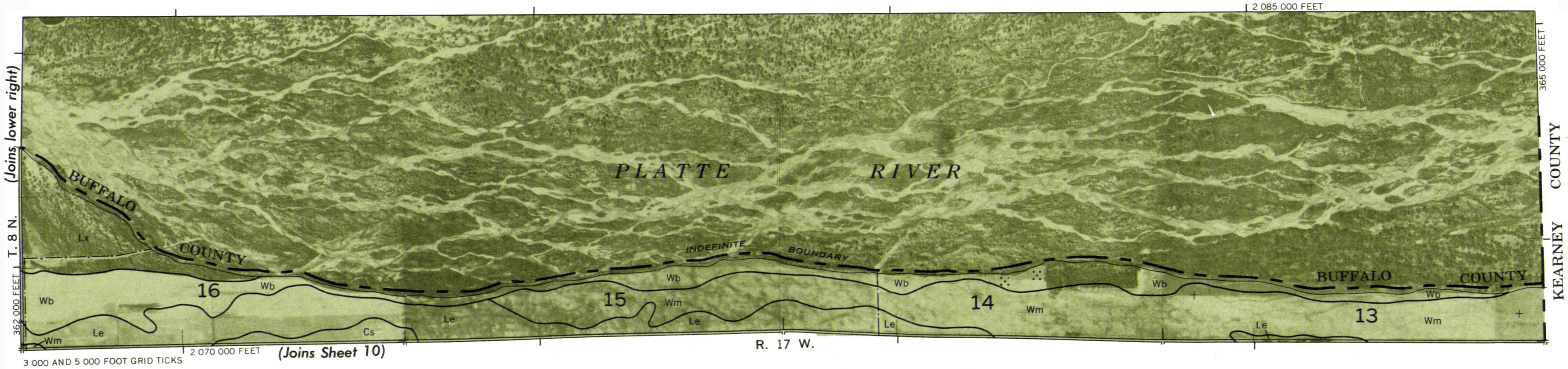

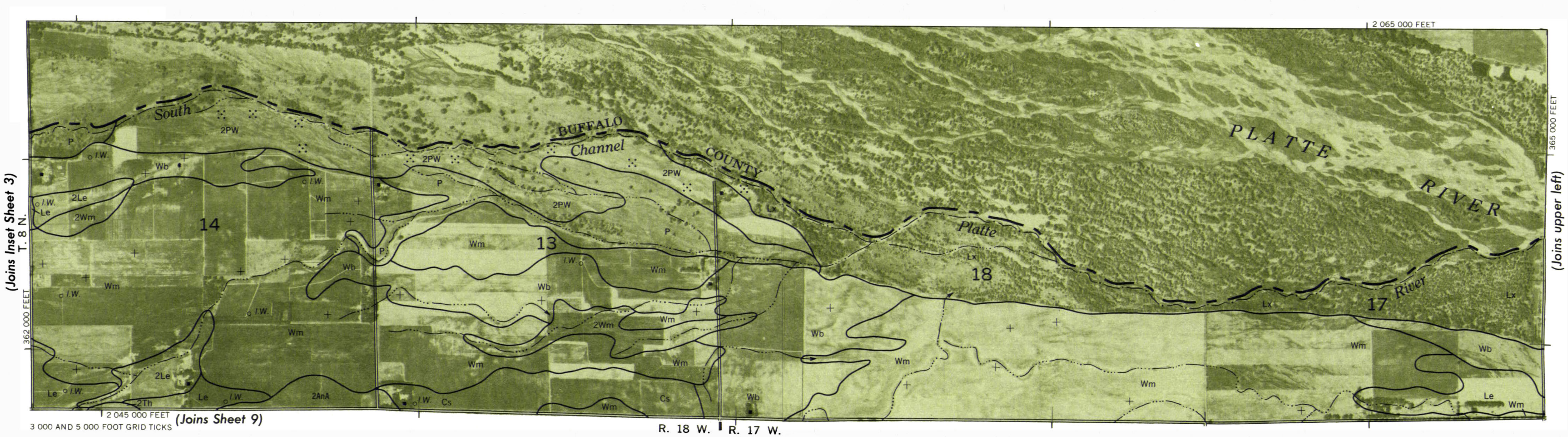

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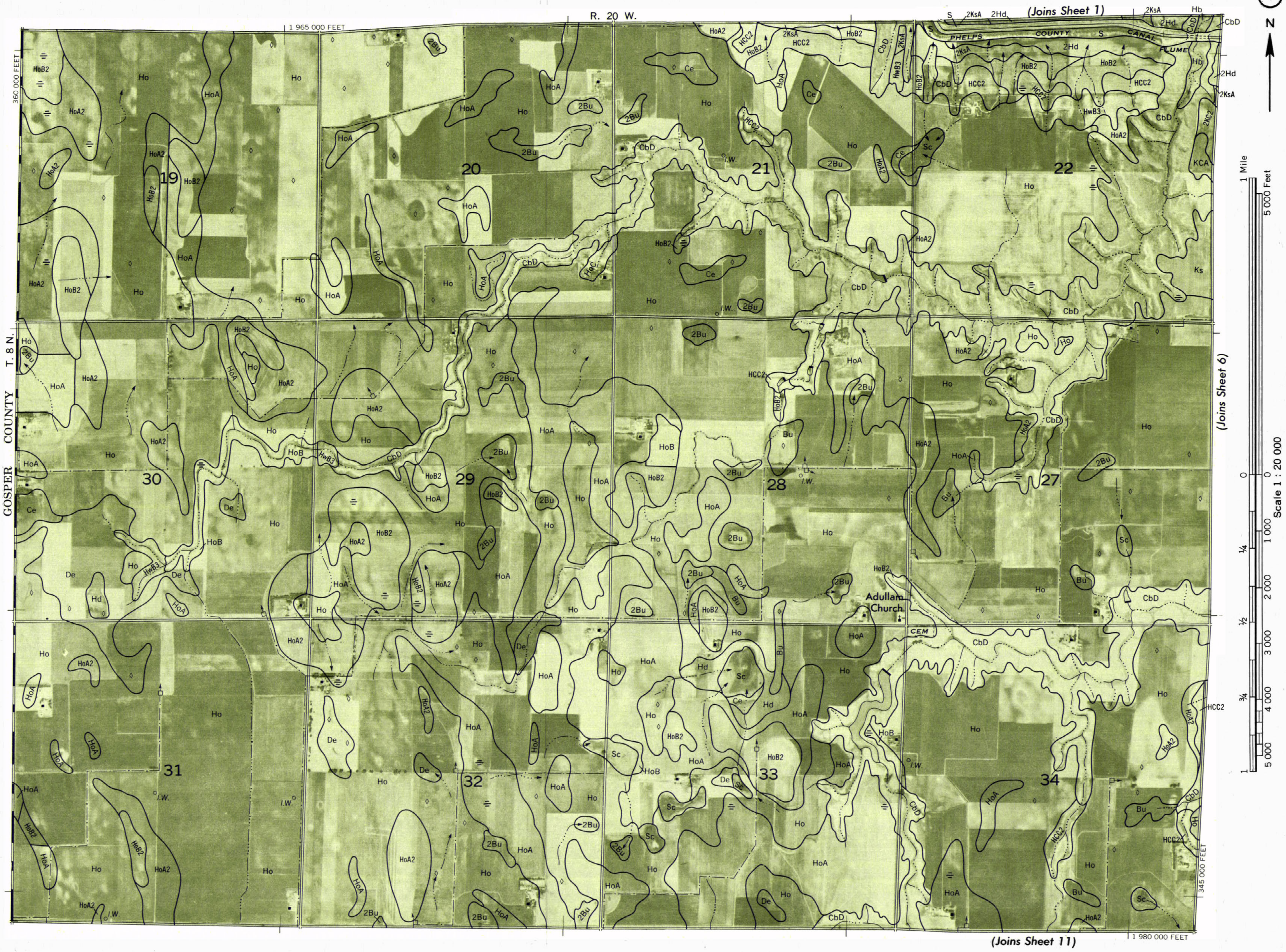

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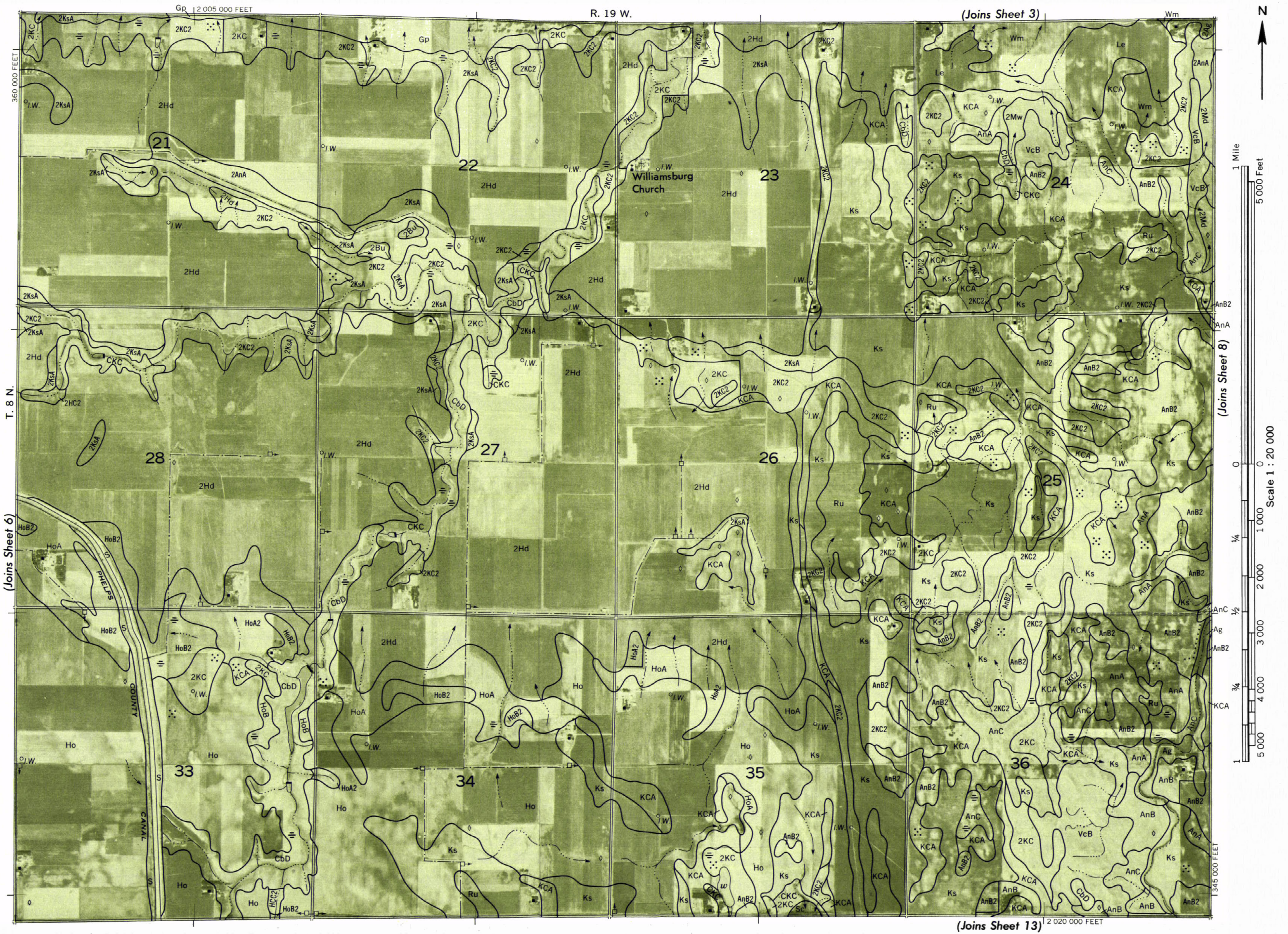

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PHELPS COUNTY, NEBRASKA — SHEET NUMBER 8

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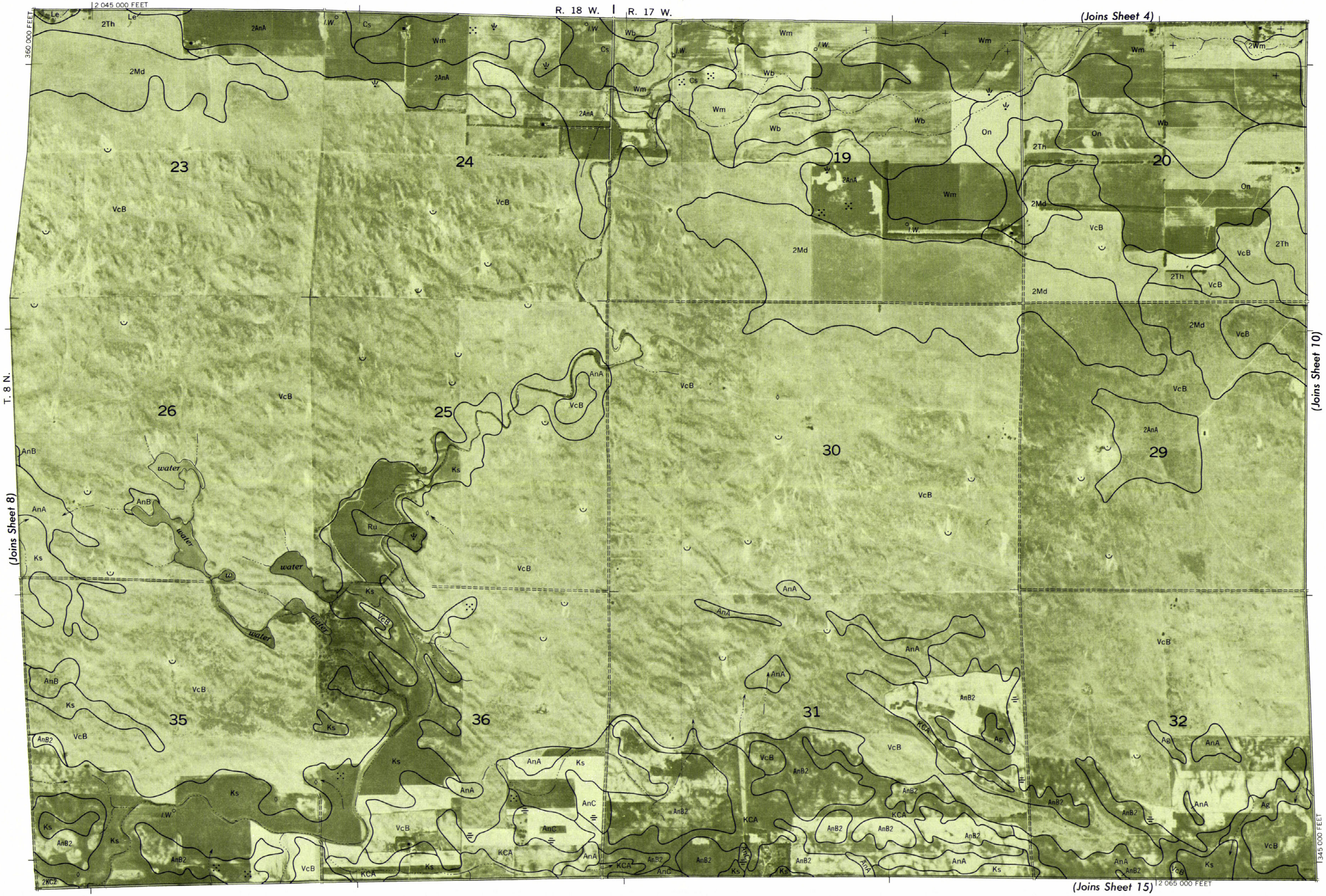

N

Scale 1 : 20 000

1 Mile

5 000 Feet

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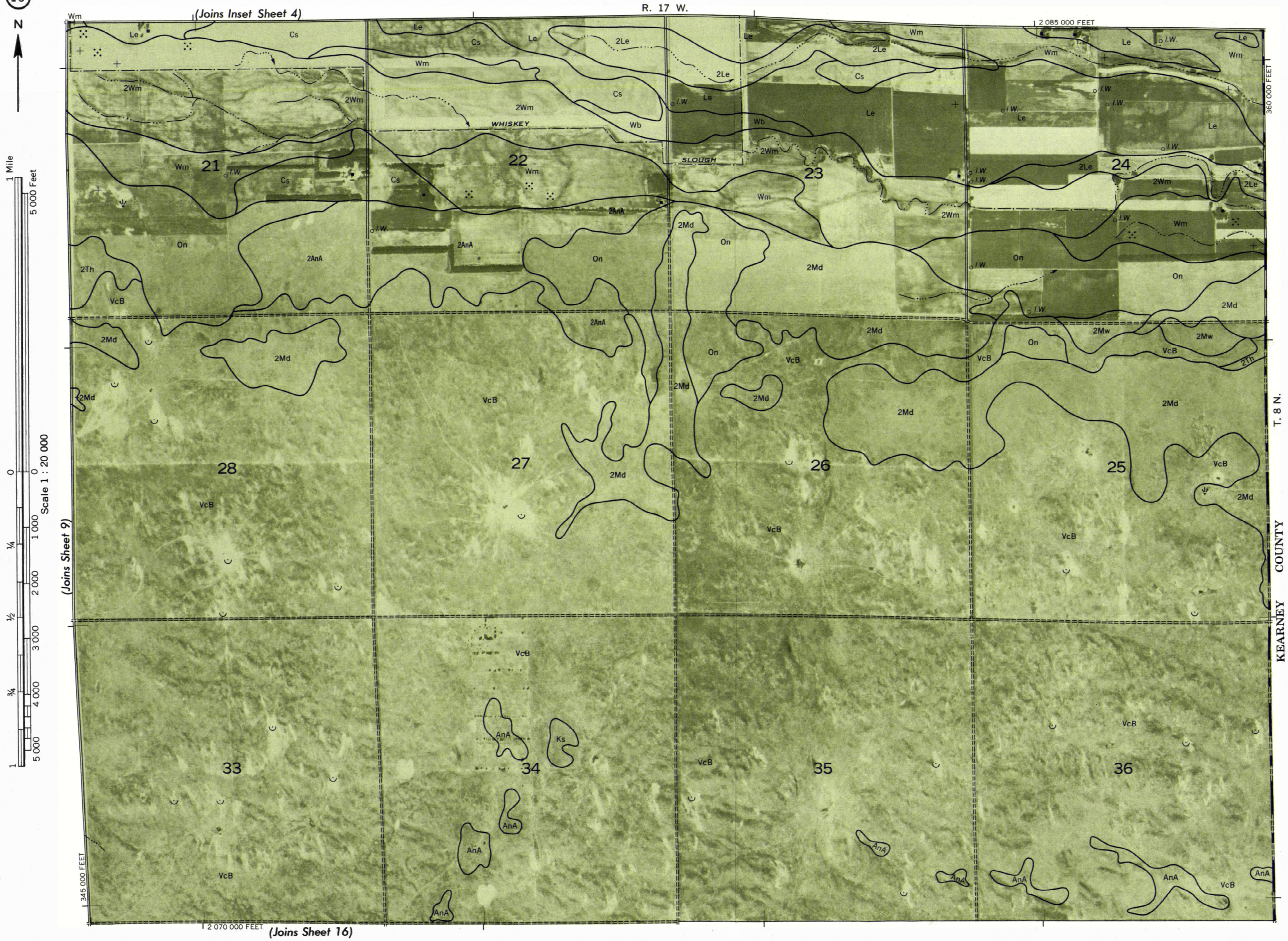

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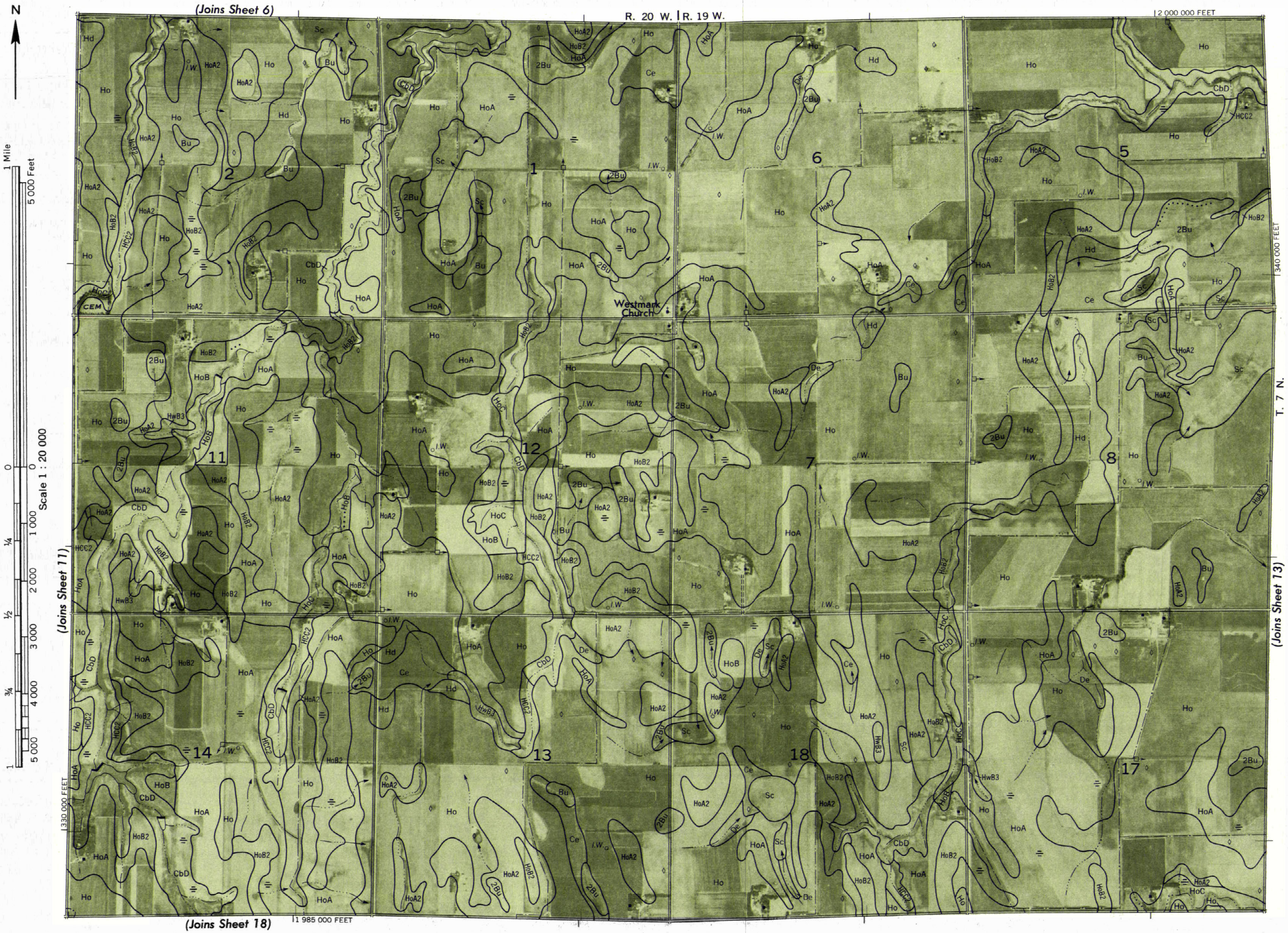
PHELPS COUNTY, NEBRASKA NO. 11

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 12



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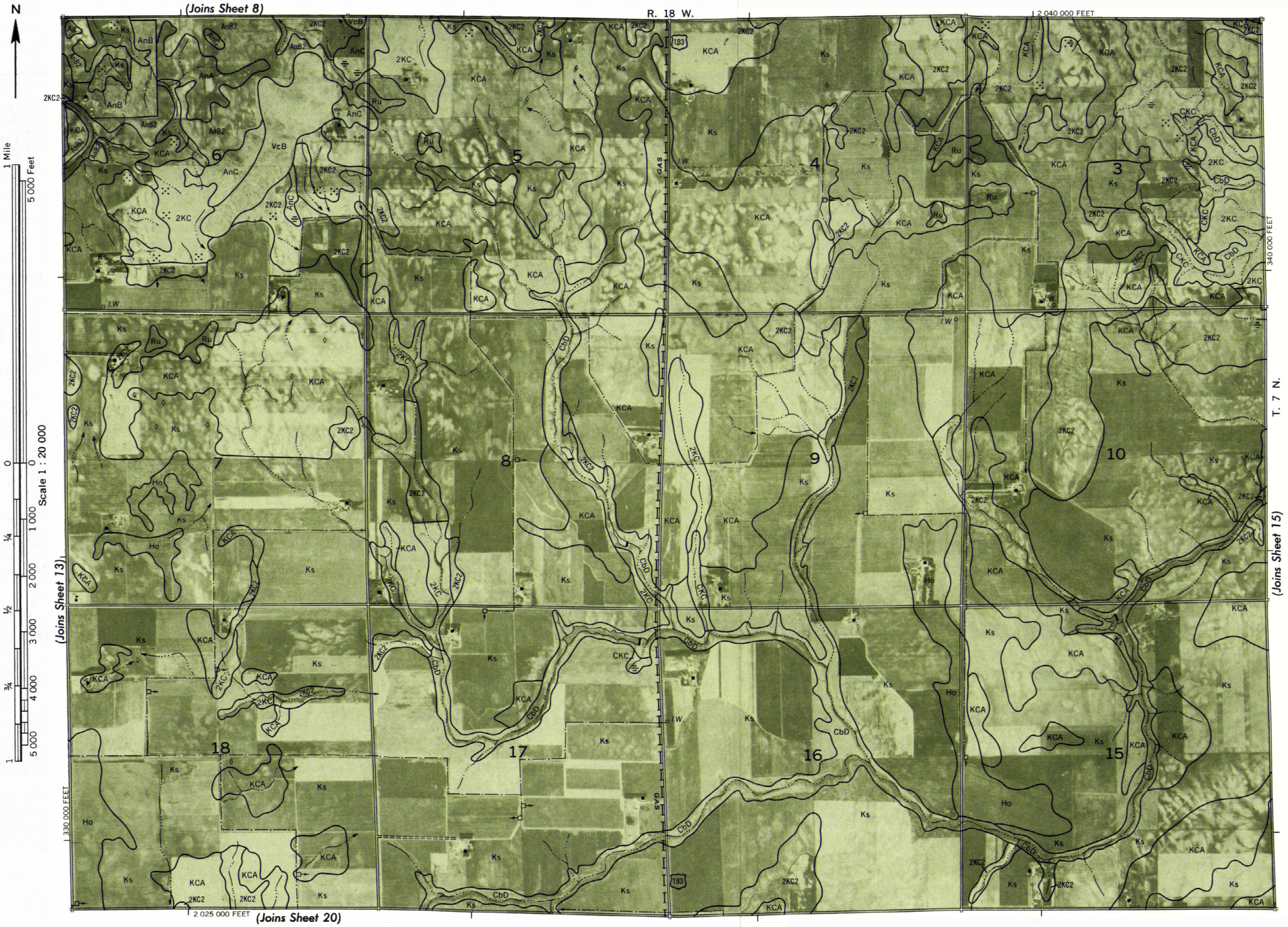

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16

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 16

PHELPS COUNTY, NEBRASKA NO. 16

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N

1 Mile
5 000 Feet

Scale 1 : 20 000

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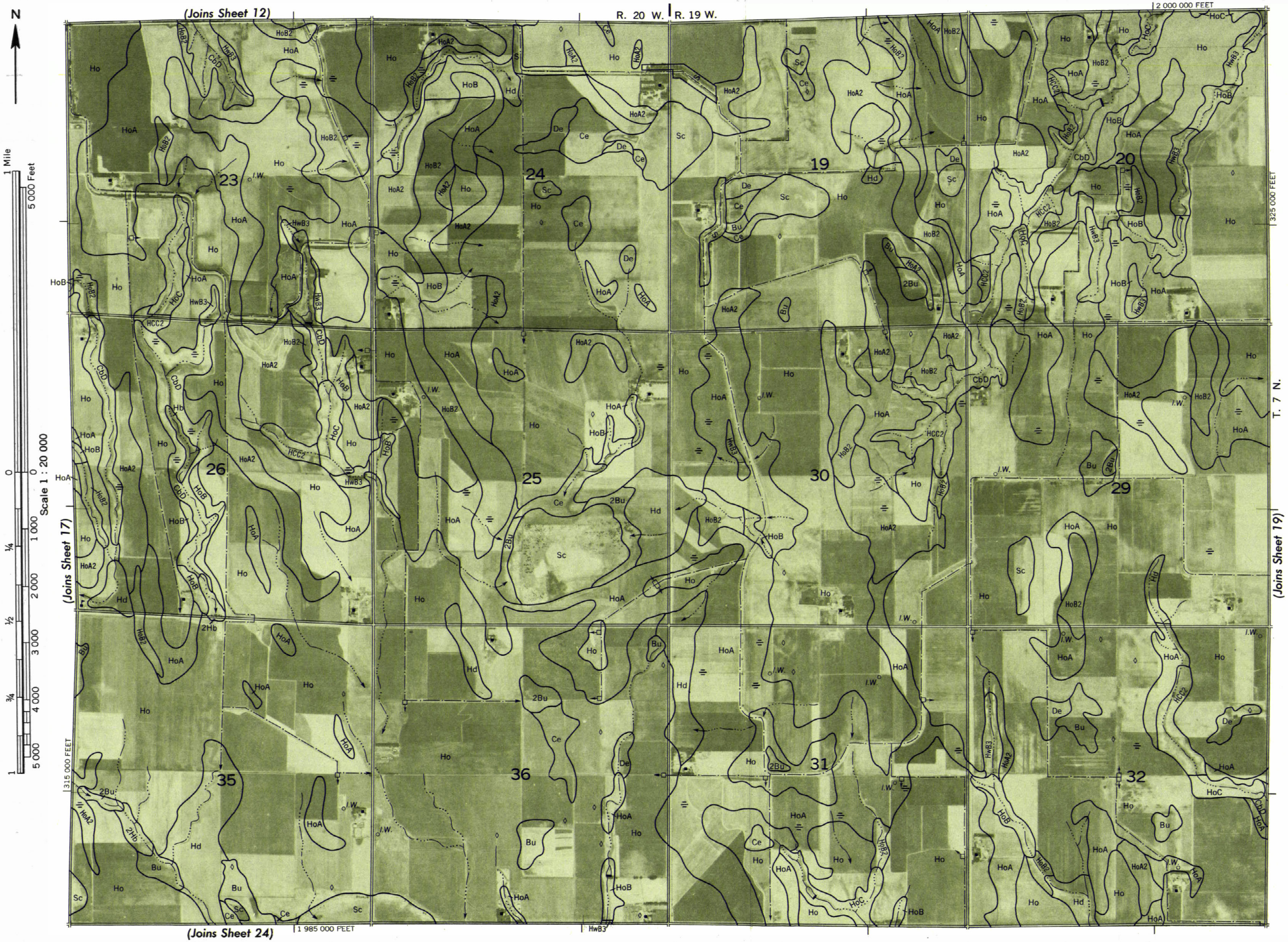
PHELPS COUNTY, NEBRASKA NO. 17



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PHELPS COUNTY, NEBRASKA NO. 19

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 20

PHELPS COUNTY, NEBRASKA NO. 20

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

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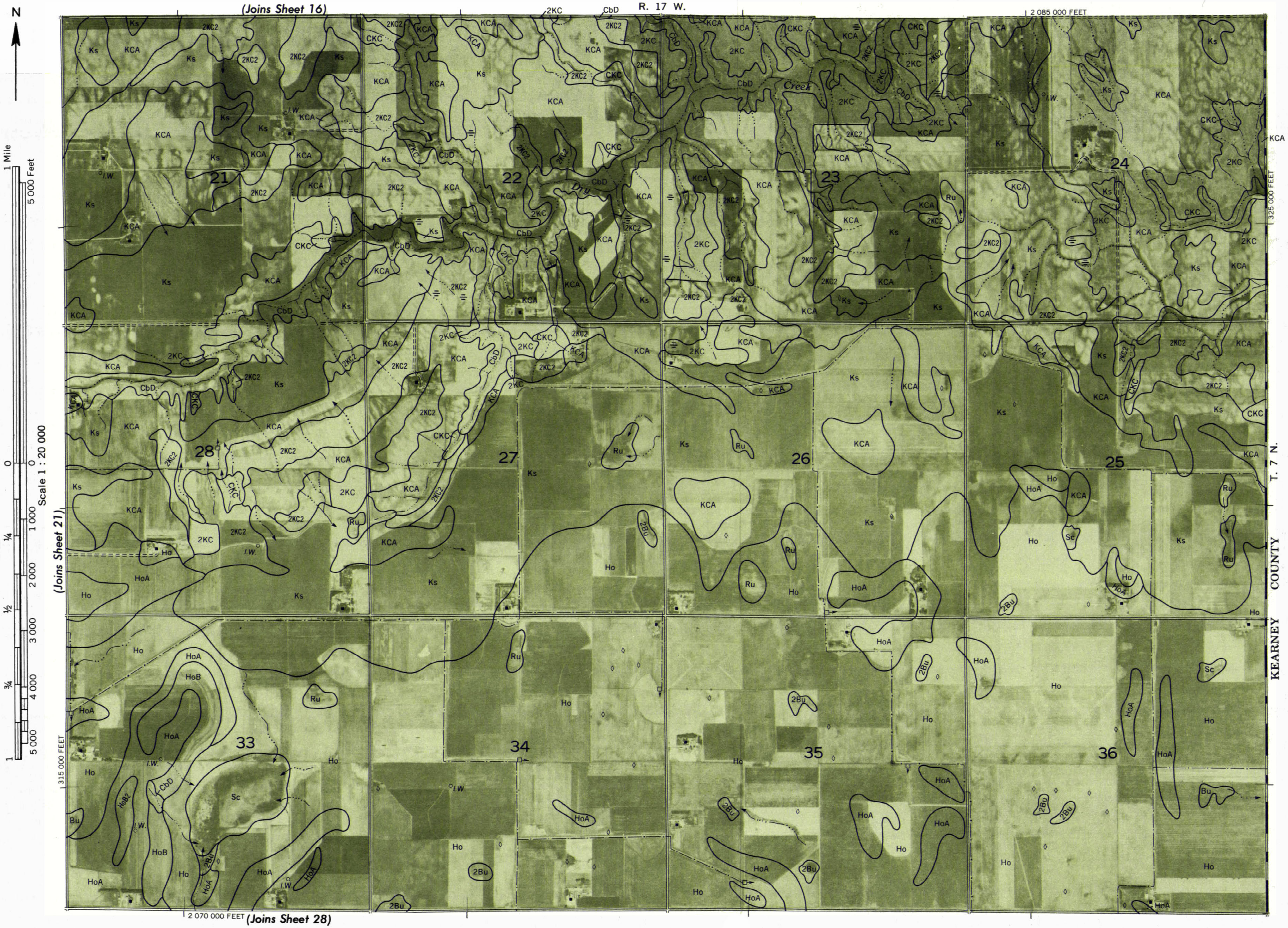
PHELPS COUNTY, NEBRASKA NO. 21

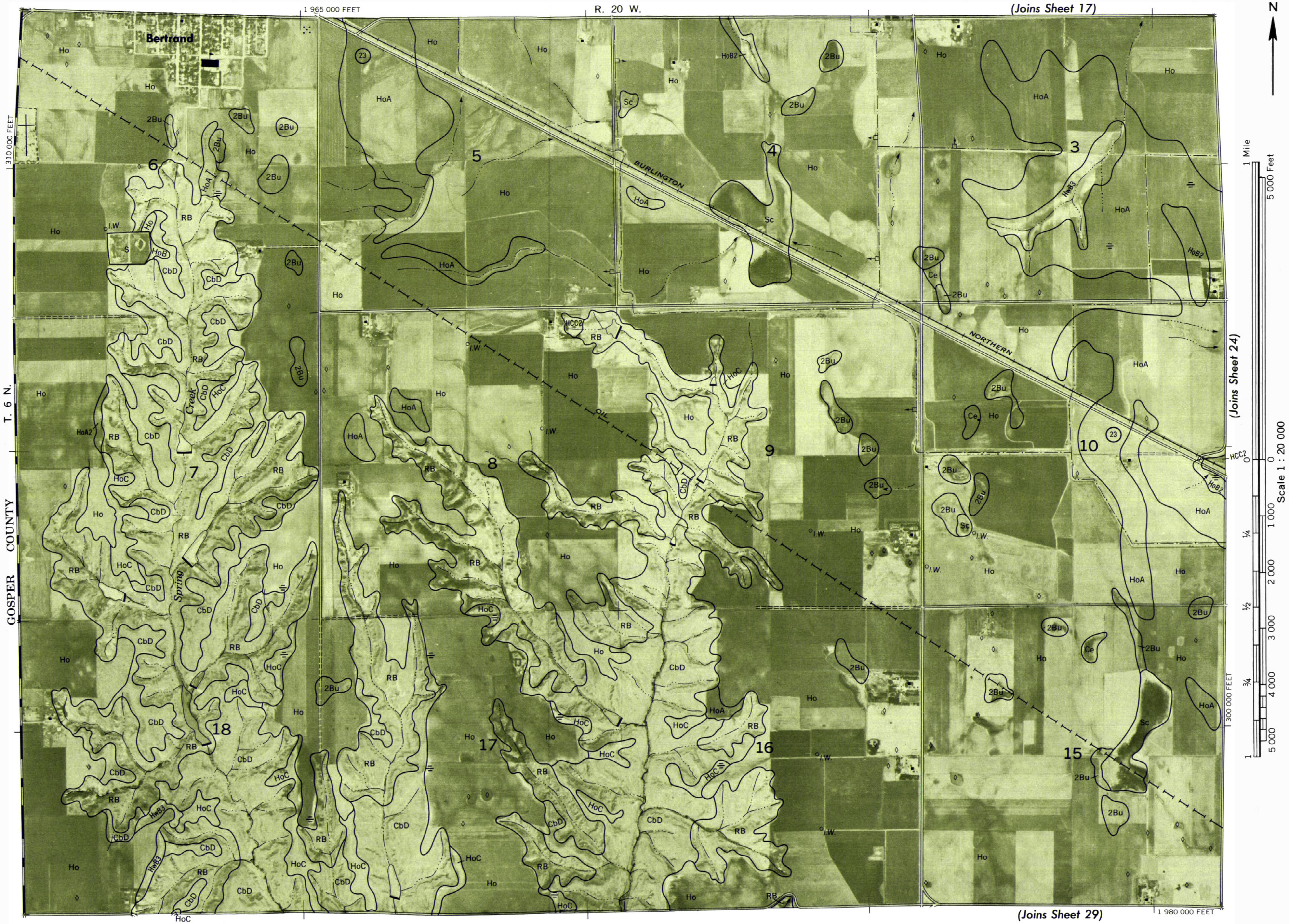
PHELPS COUNTY, NEBRASKA — SHEET NUMBER 22



PHELPS COUNTY, NEBRASKA NO. 22

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

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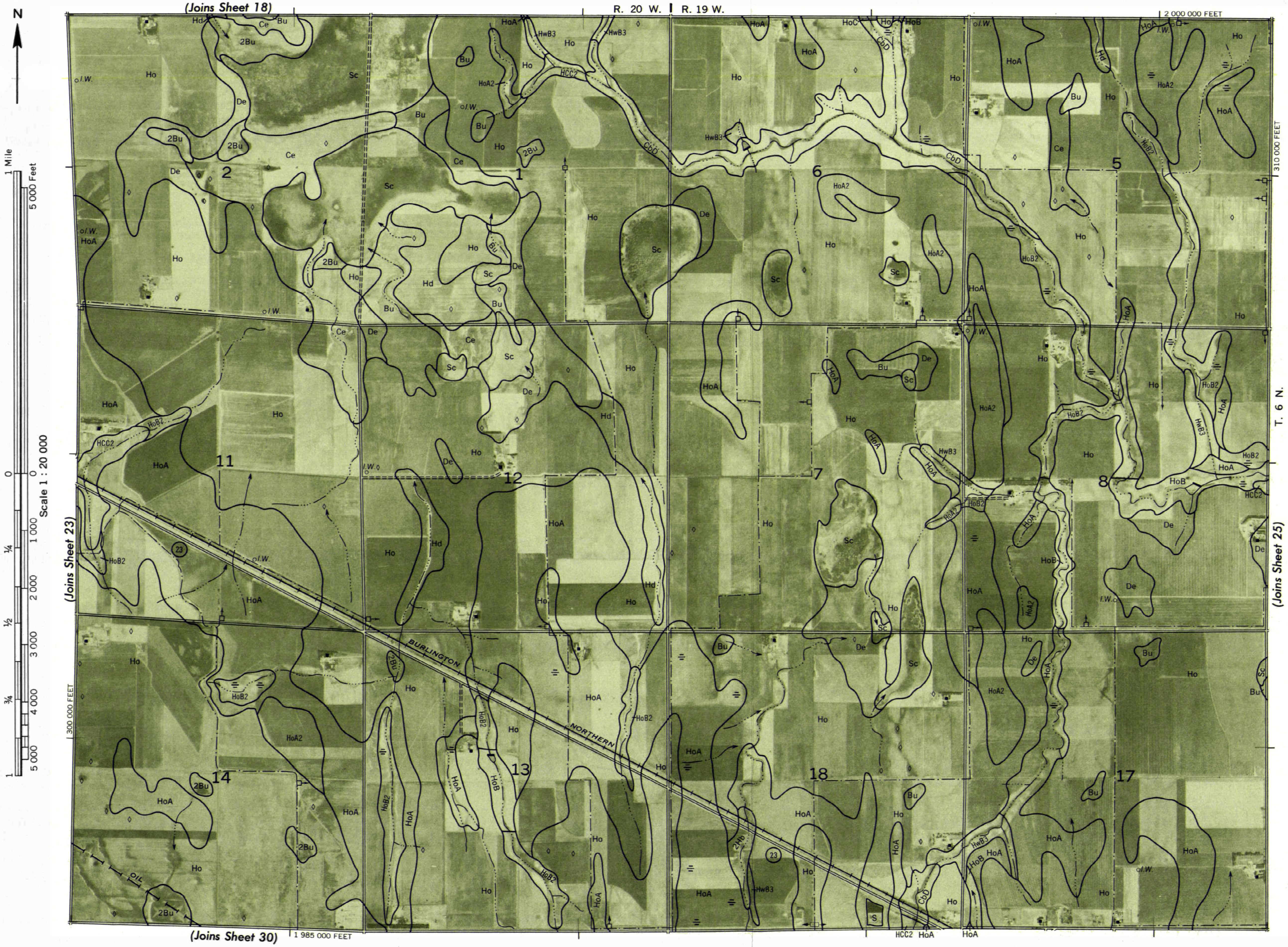
PHELPS COUNTY, NEBRASKA NO. 23

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 24



PHELPS COUNTY, NEBRASKA NO. 24

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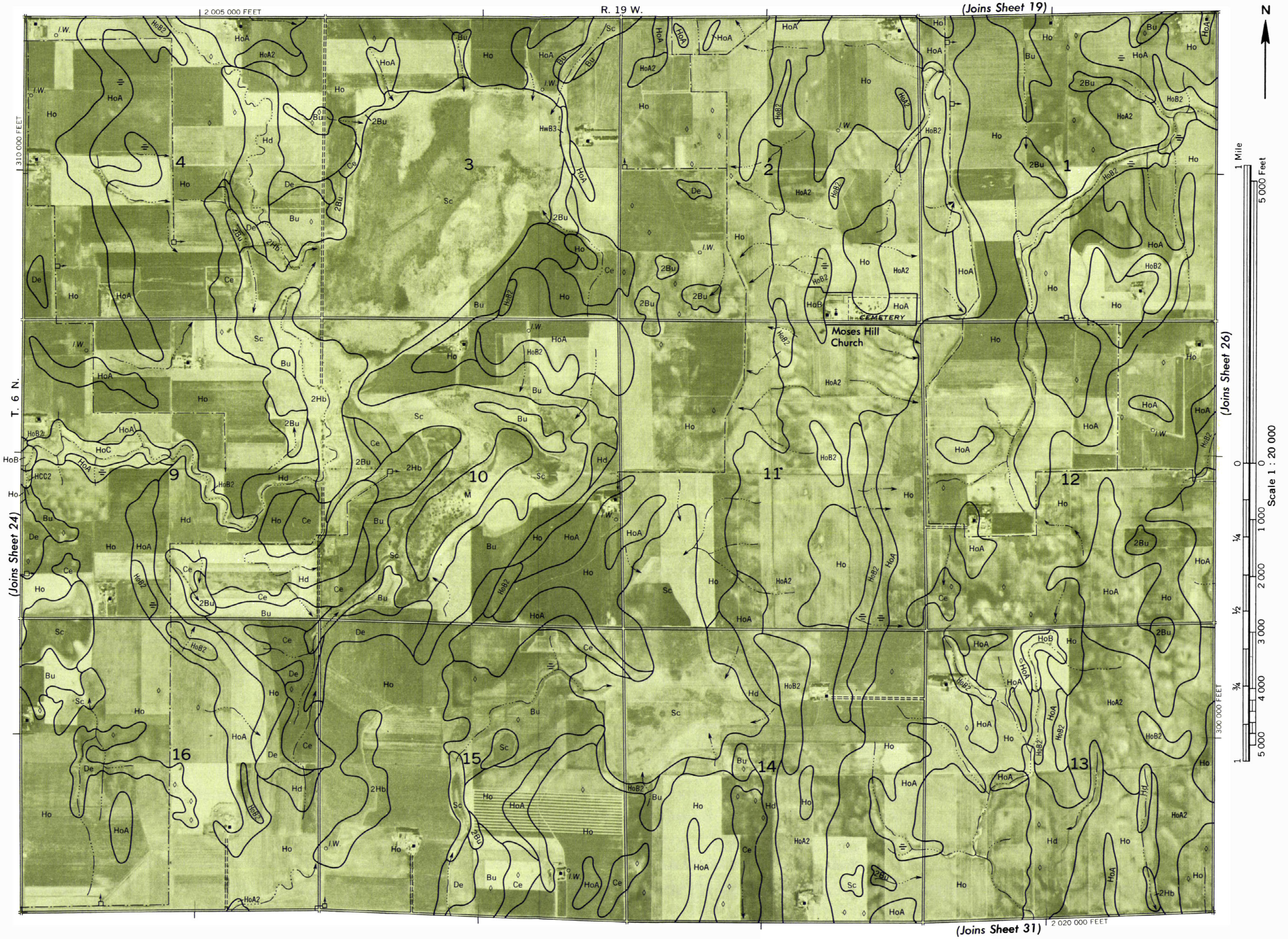
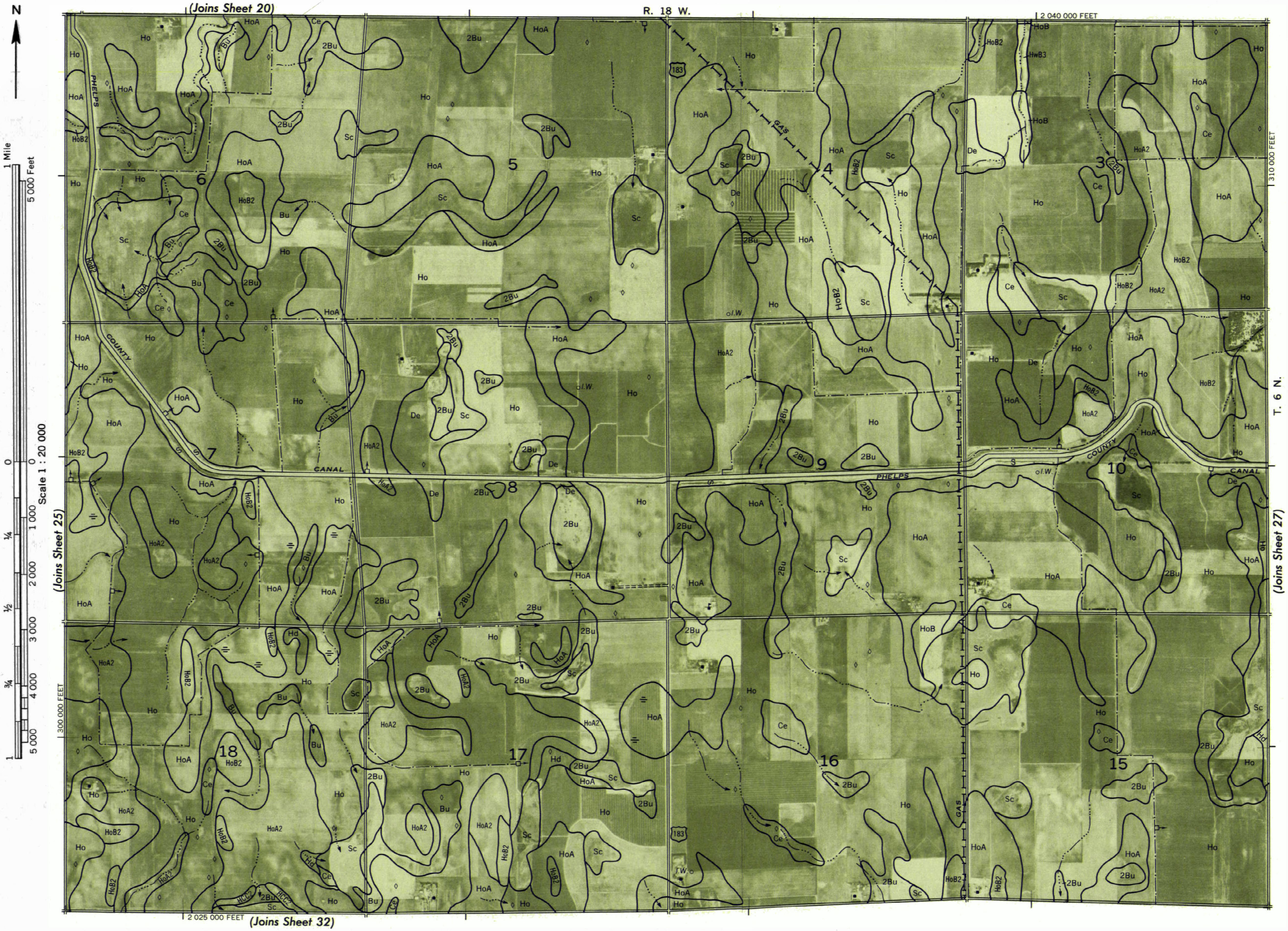


This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 25

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 26



PHELPS COUNTY, NEBRASKA NO. 26

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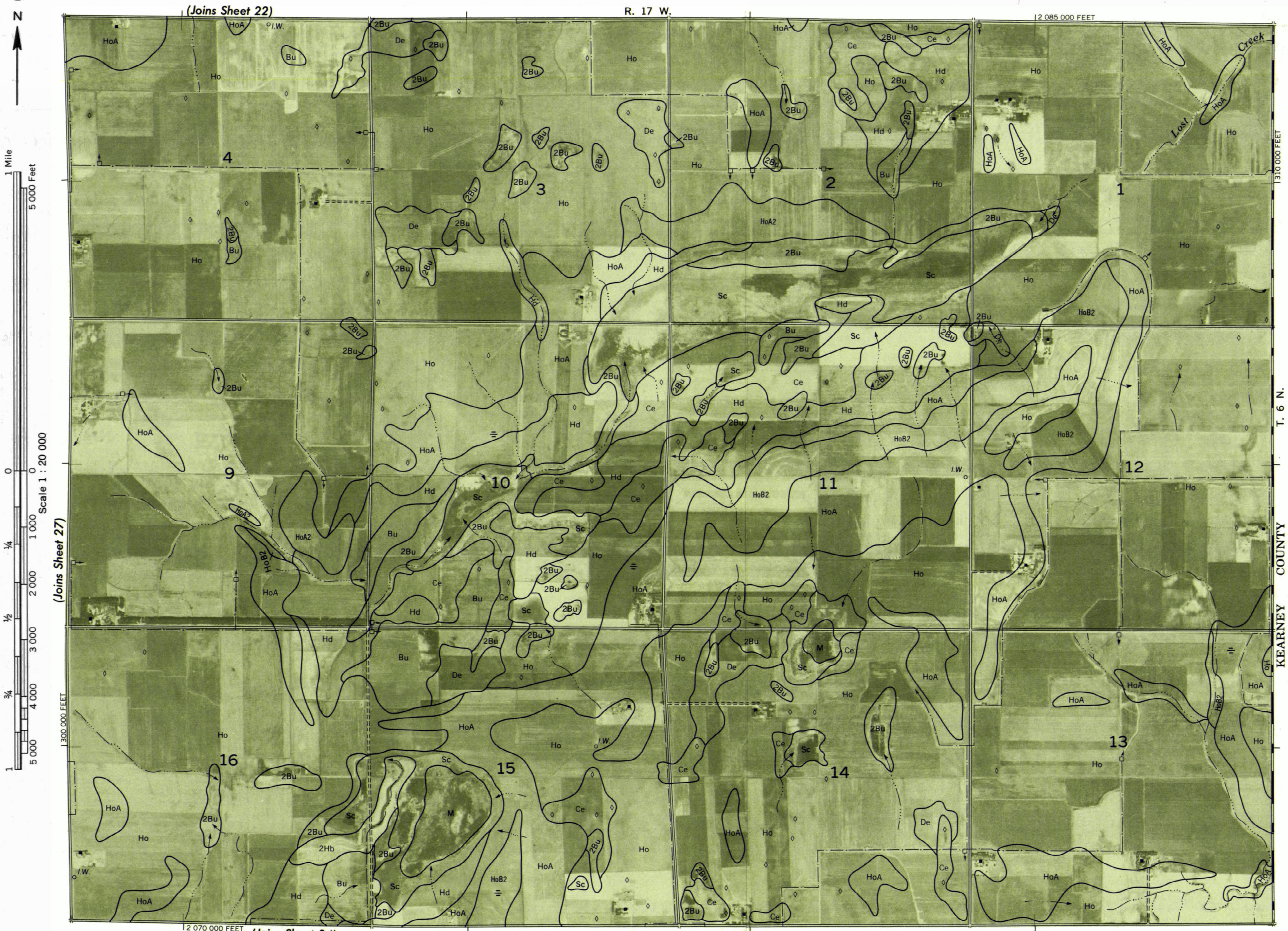
PHELPS COUNTY, NEBRASKA NO. 27

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 28



PHELPS COUNTY, NEBRASKA NO. 28

Land division corners are approximately positioned on this map.

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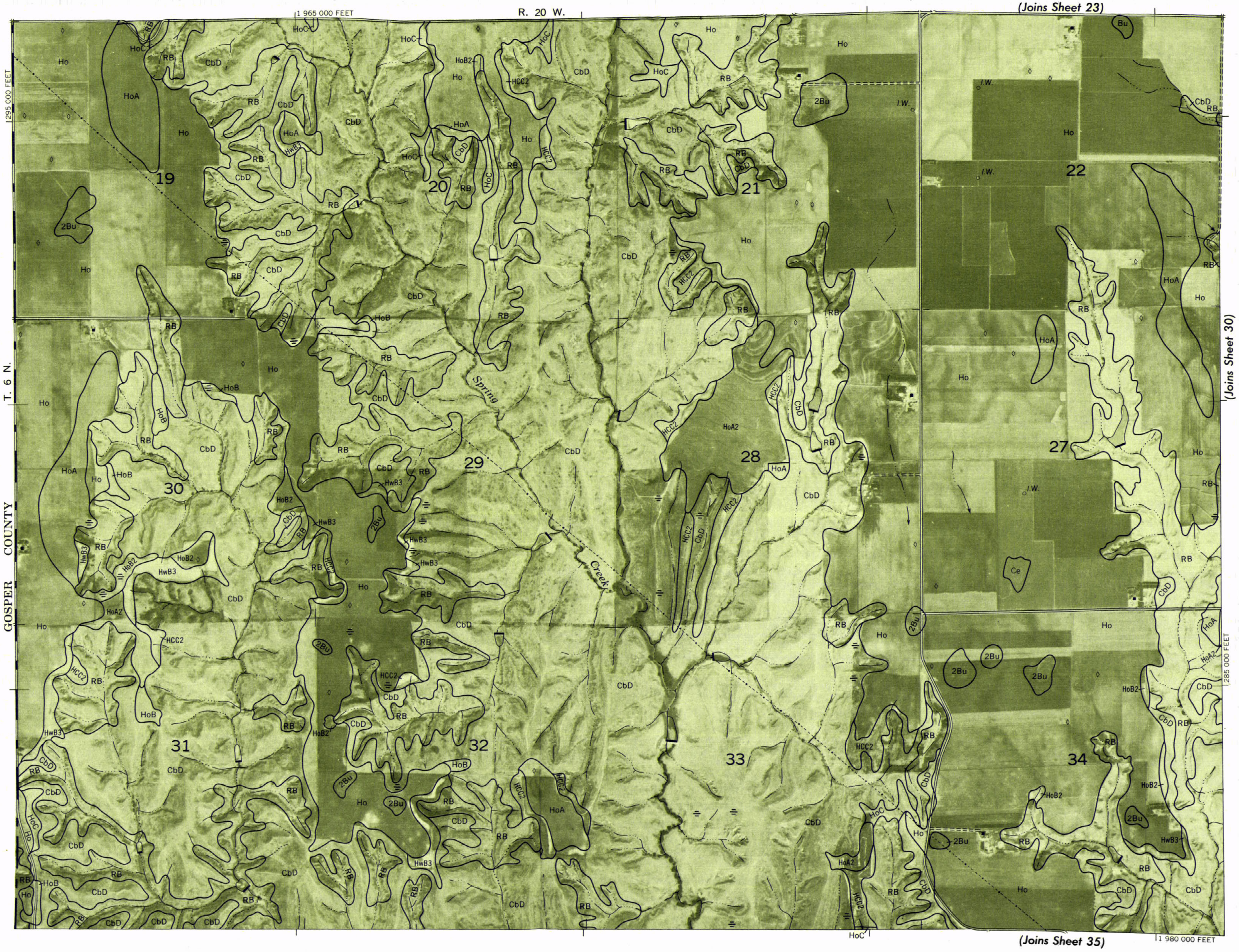
PHELPS COUNTY, NEBRASKA NO. 29



N

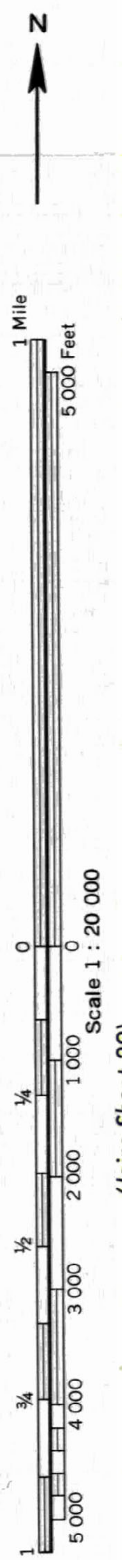
1 Mile

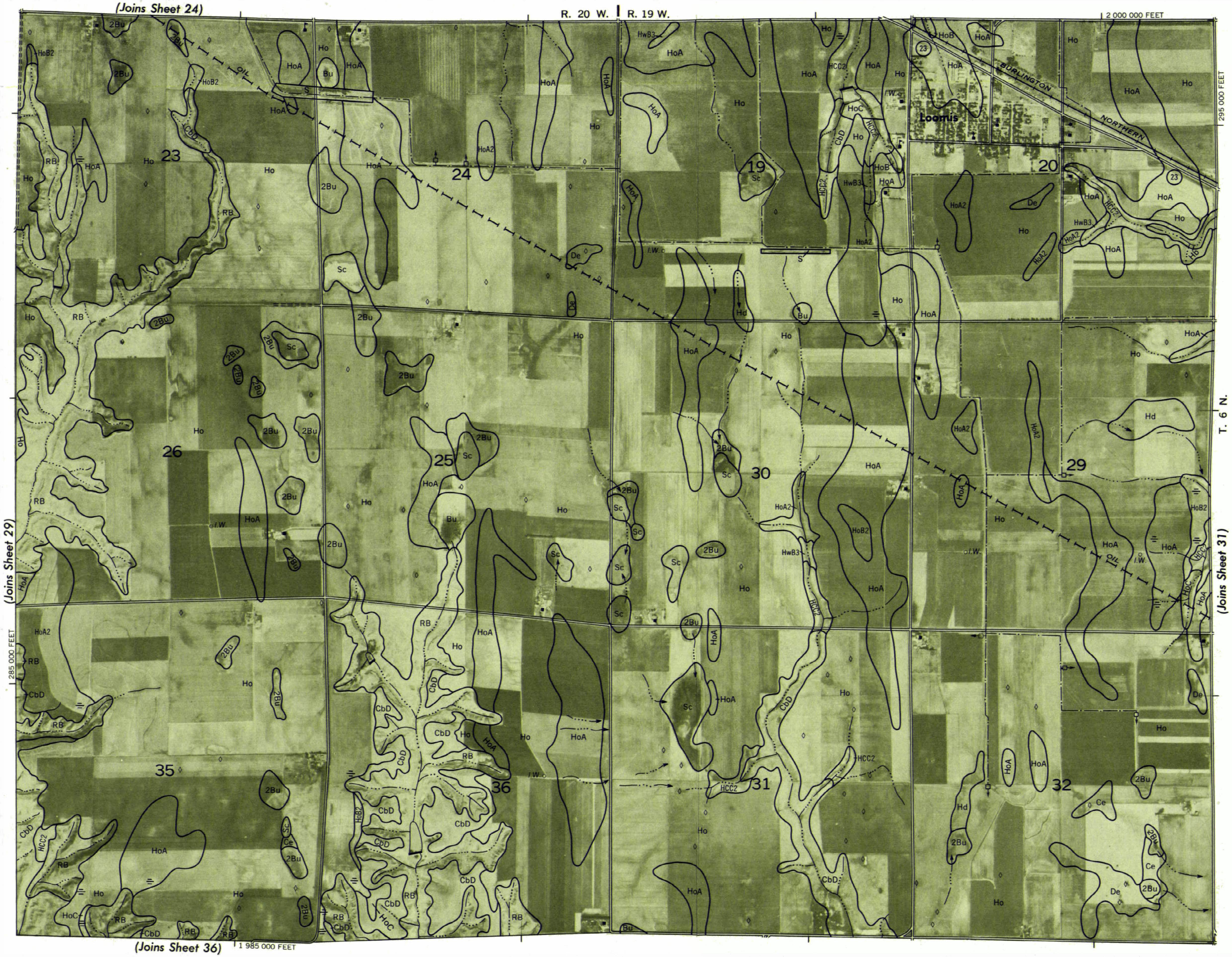
5 000 Feet

Scale 1 : 20 000

30

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 30





PHELPS COUNTY, NEBRASKA NO. 30

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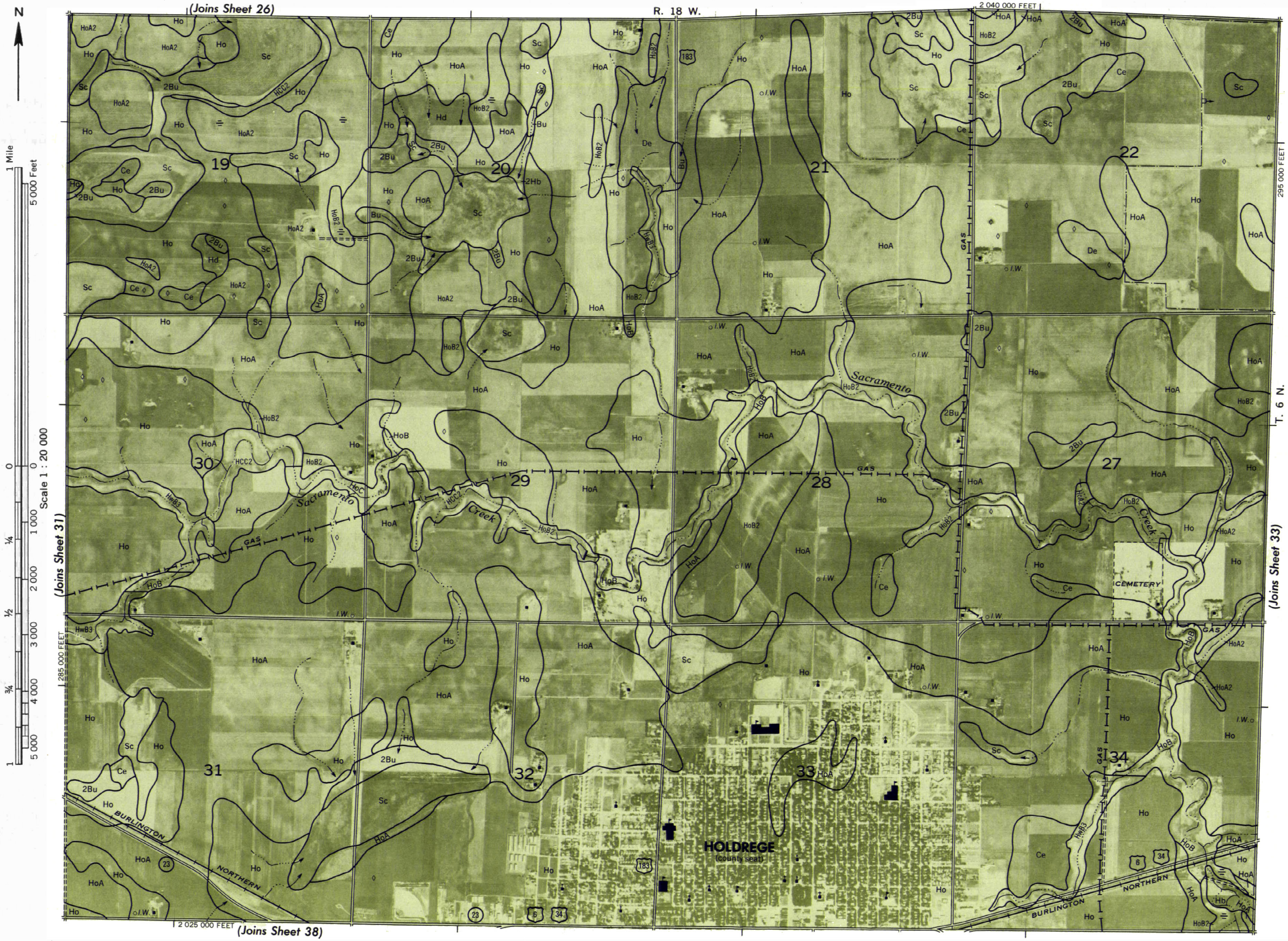
Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 31



PHELPS COUNTY, NEBRASKA NO. 32

Land division corners are approximately positioned on this map.

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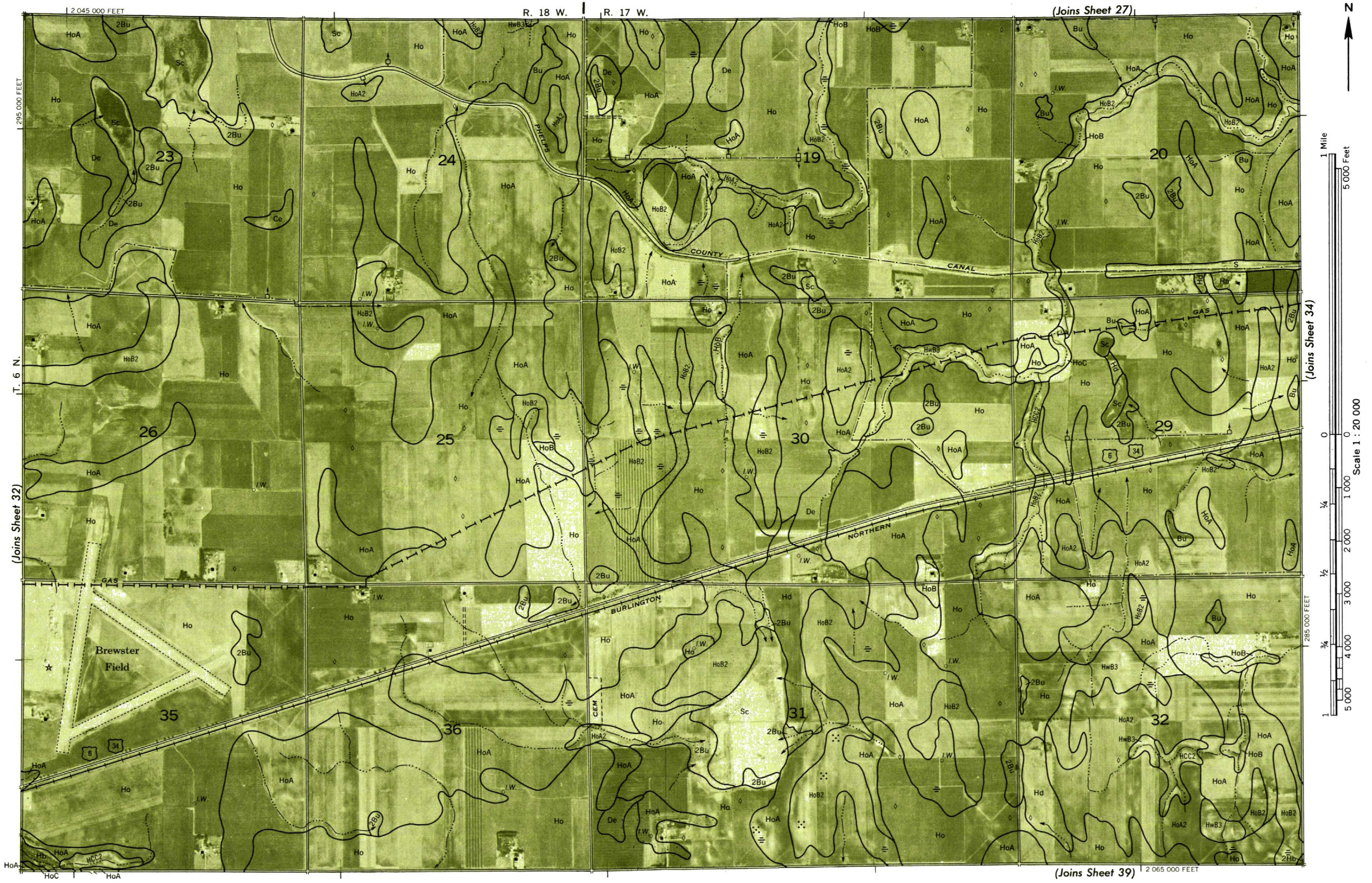


This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 33

34

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 34

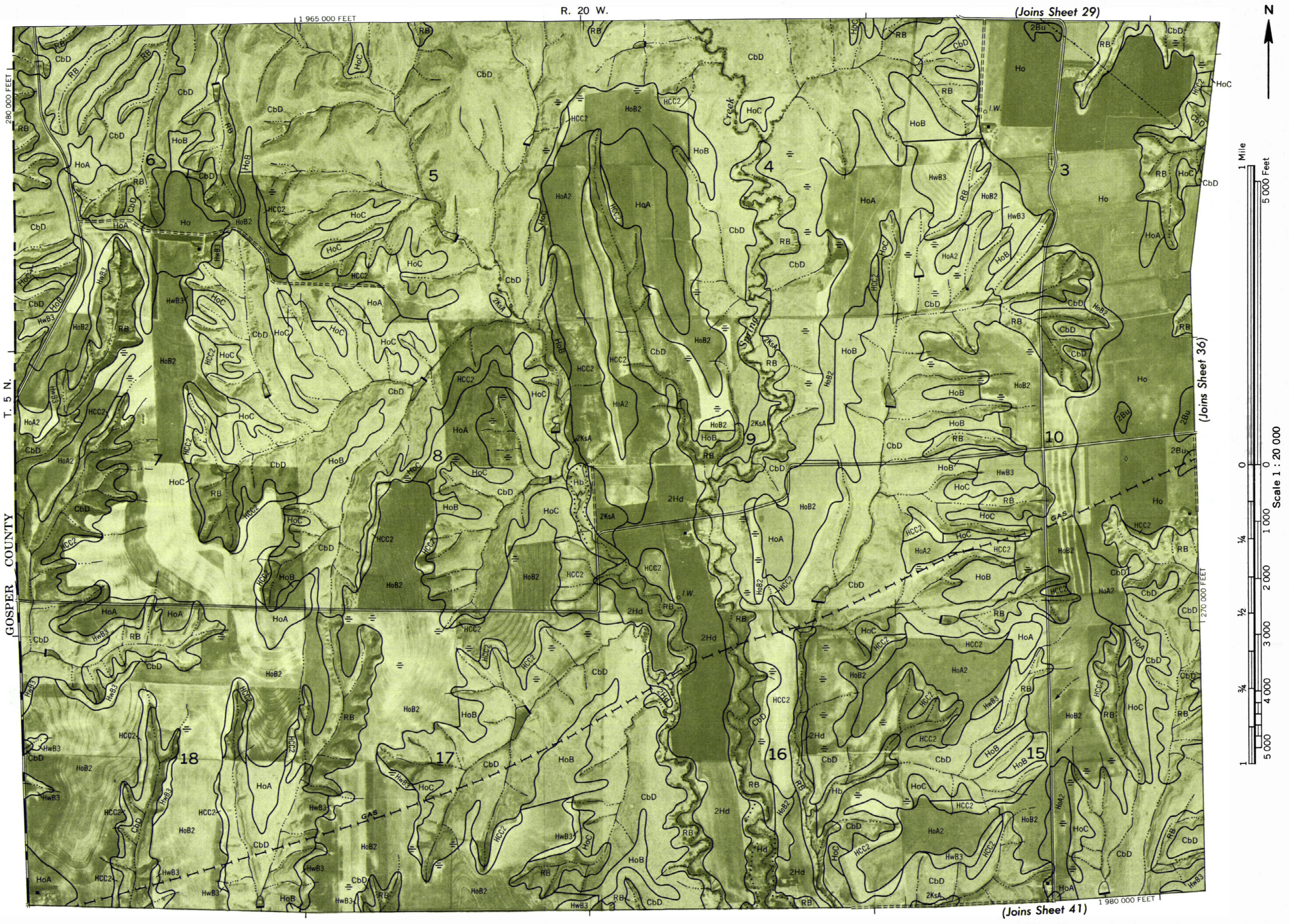
PHELPS COUNTY, NEBRASKA NO. 34

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 35

35



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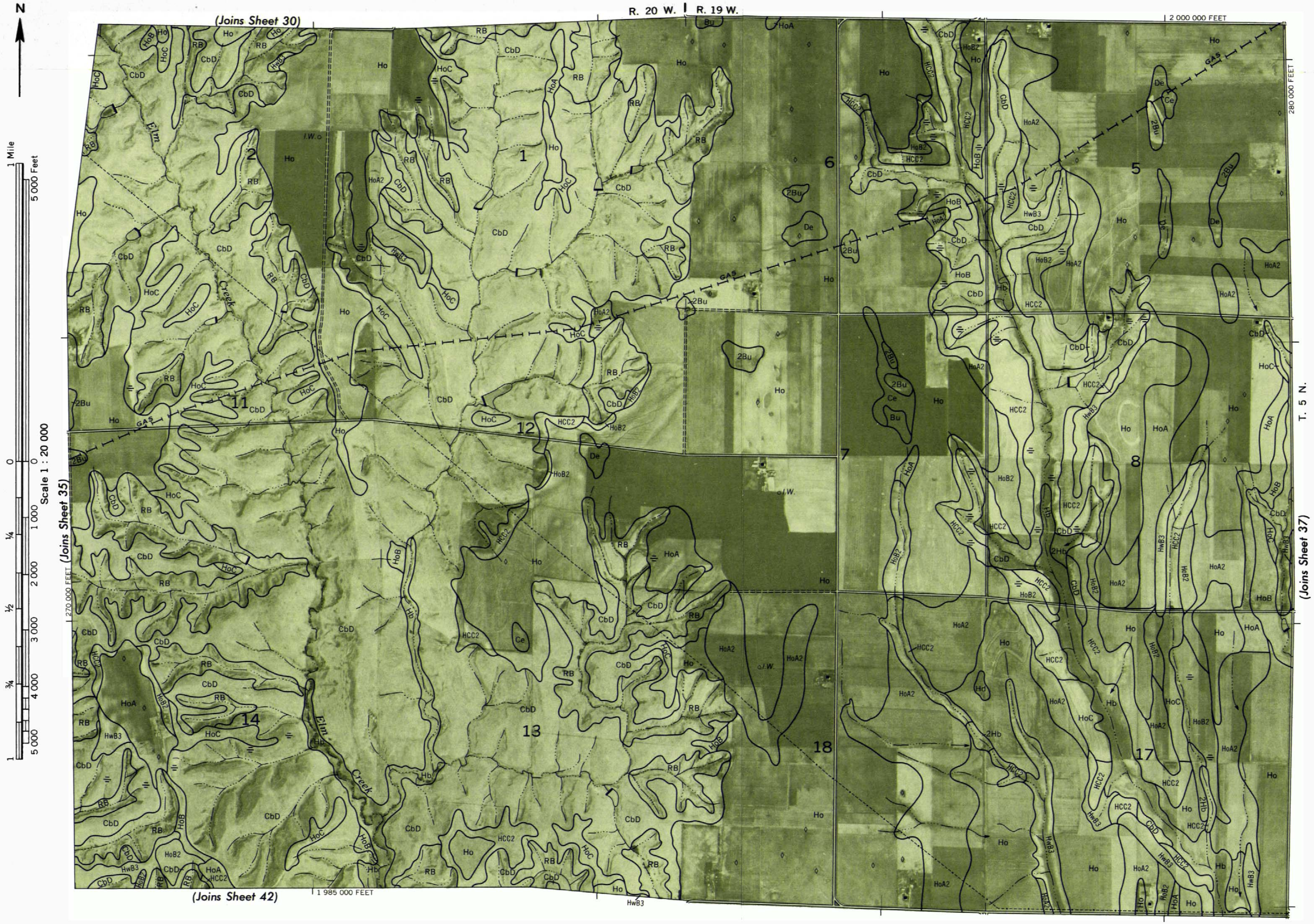
Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 35

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 36



PHELPS COUNTY, NEBRASKA NO. 36

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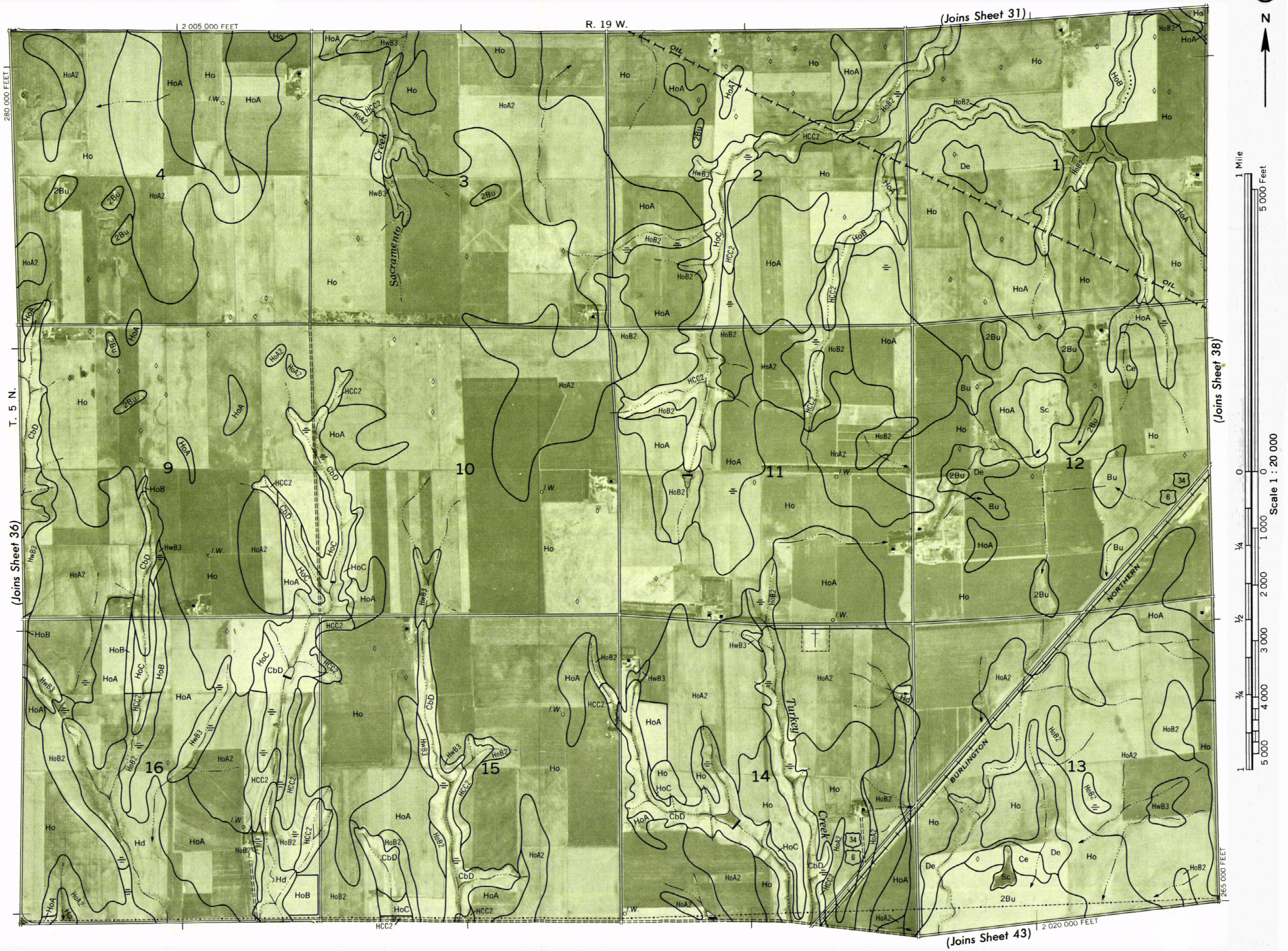
PHELPS COUNTY, NEBRASKA NO. 37



PHELPS COUNTY, NEBRASKA — SHEET NUMBER 38

PHELPS COUNTY, NEBRASKA NO. 38

Land division corners are approximately positioned on this map.

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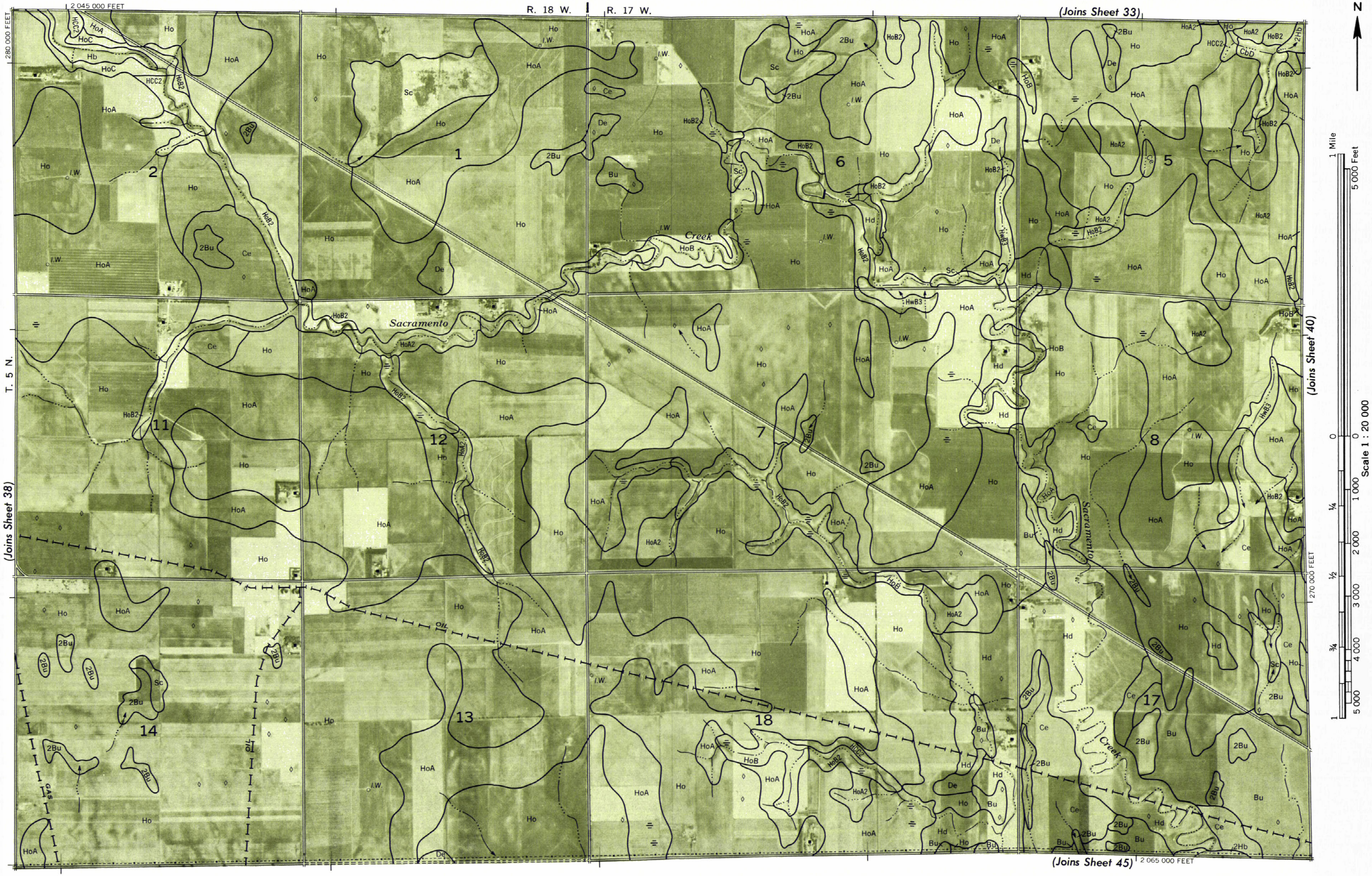

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PHELPS COUNTY, NEBRASKA NO. 39

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 40

PHELPS COUNTY, NEBRASKA NO. 40

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Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 42

N

Scale 1: 20 000

1 Mile | 5 000 Feet | ¼ | ½ | ¾ | 0 | 1 000 | 2 000 | 3 000 | 4 000 | 5 000

PHELPS COUNTY, NEBRASKA NO. 42

Land division corners are approximately positioned on this map.

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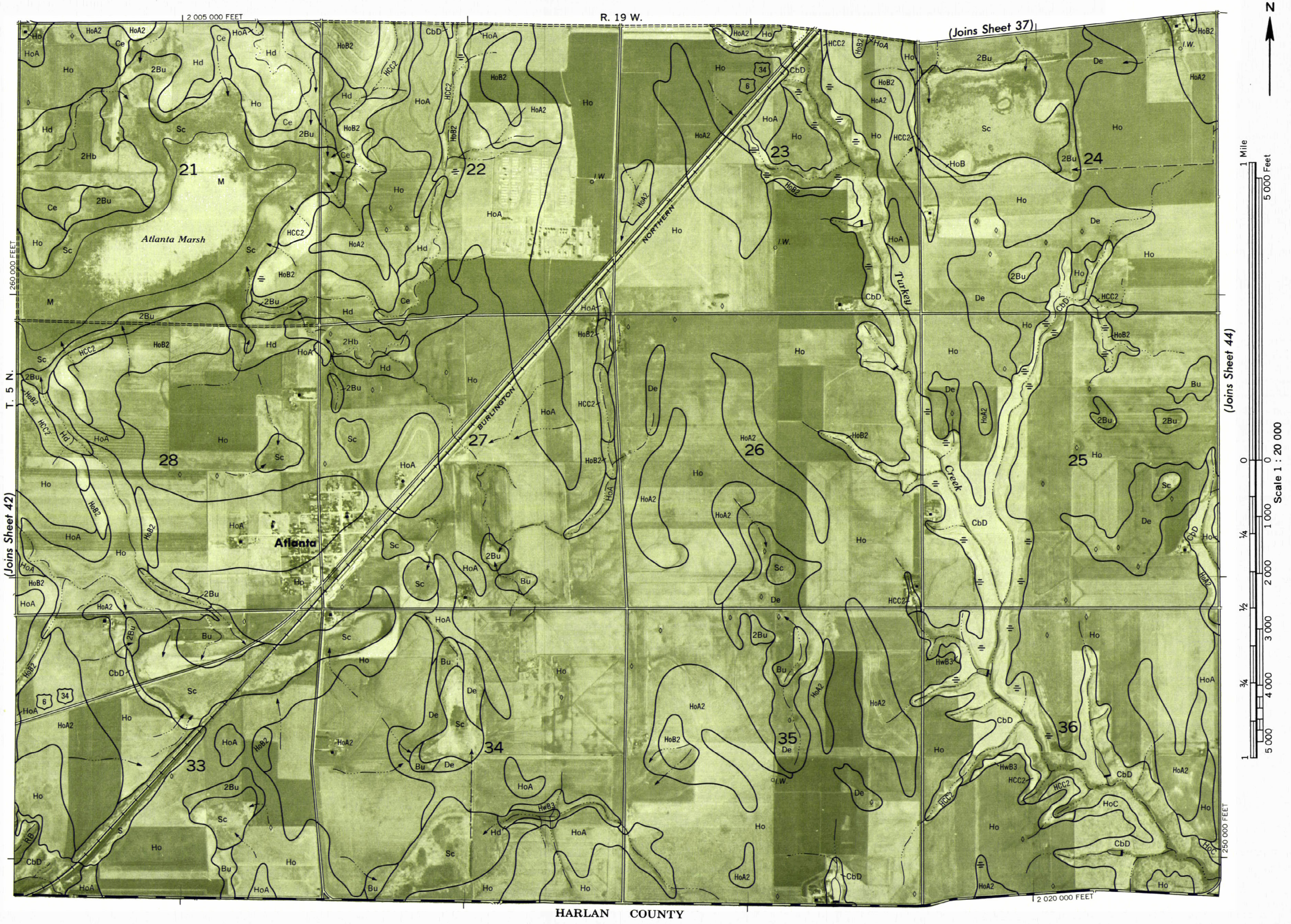

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 44

PHELPS COUNTY, NEBRASKA NO. 44

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 45

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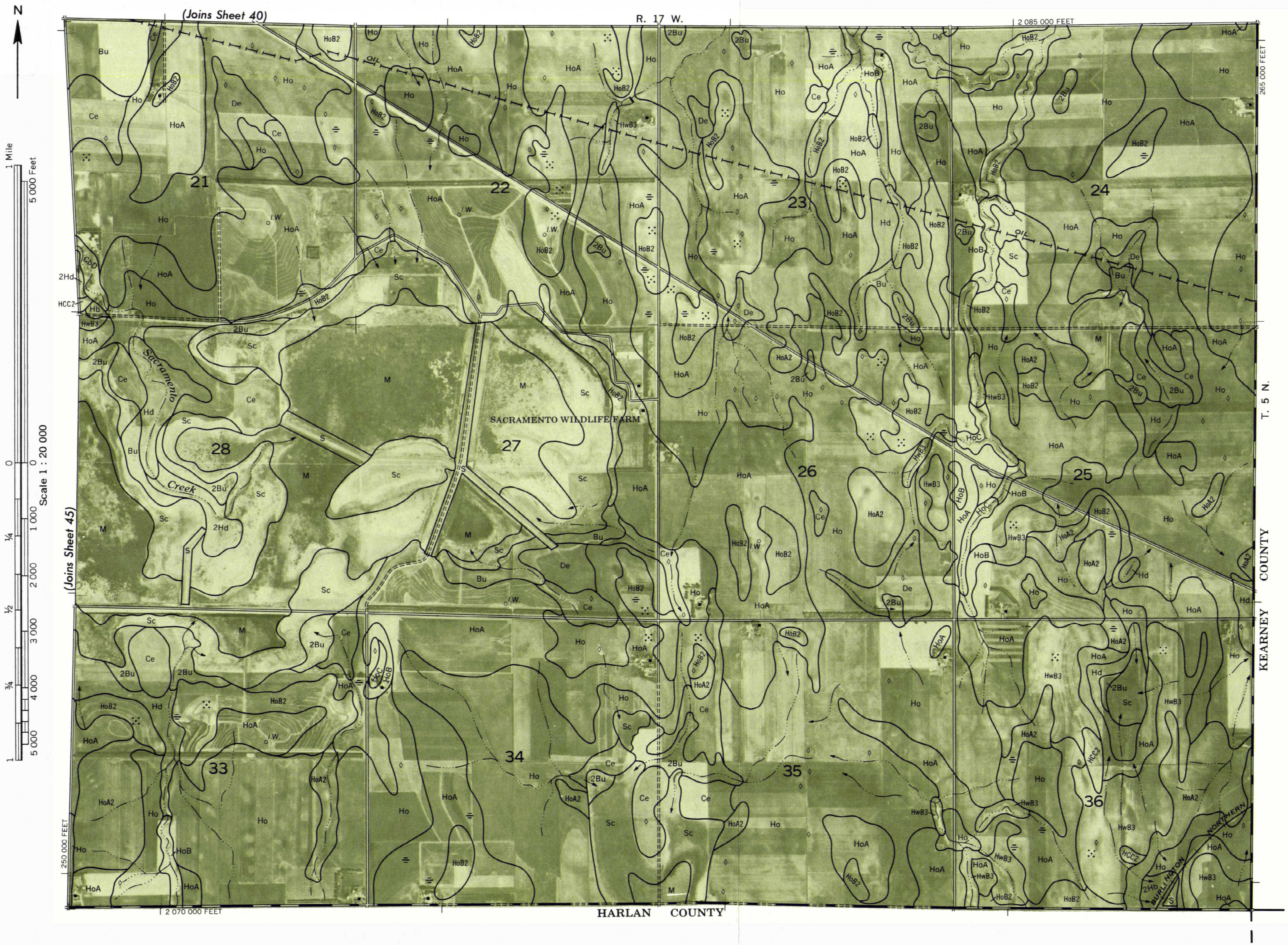
Land division corners are approximately positioned on this map.

PHELPS COUNTY, NEBRASKA NO. 45

PHELPS COUNTY, NEBRASKA — SHEET NUMBER 46



PHELPS COUNTY, NEBRASKA NO. 46

Land division corners are approximately positioned on this map.

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CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Airway beacon

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches (CANAL)

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

Well, irrigation (I.W.)

Turn out box, irrigation

RELIEF

Escarpments
- Bedrock
- Other

Prominent peak

Depressions and sinkholes (Large, Small)
- Unclassified

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Short steep slope
- Saline spot

Photobase from 1963 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

SOIL LEGEND

Each soil symbol consists of letters or of letters and numbers; for example, AnA, 2AnA, Cs, or 2PW. If slope is given in the soil name and is more than 1 percent, the last capital letter, A, B, C, or D, in a symbol shows the slope class. A final number, 2, indicates an eroded soil.

SYMBOL	NAME
Ag	Anselmo very fine sandy loam, 0 to 1 percent slopes
2Ag	Anselmo very fine sandy loam, terrace, 0 to 1 percent slopes
AnA	Anselmo fine sandy loam, 0 to 3 percent slopes
2AnA	Anselmo fine sandy loam, terrace, 0 to 3 percent slopes
AnB	Anselmo fine sandy loam, hummocky
AnB2	Anselmo fine sandy loam, hummocky, eroded
AnC	Anselmo fine sandy loam, 7 to 10 percent slopes
Bu	Butler silt loam
2Bu	Butler silt loam, depressional
CbD	Coly silt loam, 10 to 30 percent slopes
Ce	Crete silt loam
CKC	Coly and Kenesaw silt loams, 7 to 10 percent slopes
Coz	Cozad silt loam
Cs	Cass fine sandy loam
De	Detroit silt loam
Gp	Grigston silt loam
Hb	Hobbs silt loam
2Hb	Hobbs silt loam, overwash
HCC2	Holdrege-Coly complex, 7 to 10 percent slopes, eroded
Hd	Hord silt loam
2Hd	Hord silt loam, terrace
Ho	Holdrege silt loam, 0 to 1 percent slopes
HoA	Holdrege silt loam, 1 to 3 percent slopes
HoA2	Holdrege silt loam, 1 to 3 percent slopes, eroded
HoB	Holdrege silt loam, 3 to 7 percent slopes
HoB2	Holdrege silt loam, 3 to 7 percent slopes, eroded
HoC	Holdrege silt loam, 7 to 10 percent slopes
HwB3	Holdrege soils, 3 to 7 percent slopes, severely eroded
KCA	Kenesaw and Coly silt loams, 1 to 3 percent slopes
2KC	Kenesaw and Coly silt loams, hummocky
2KC2	Kenesaw and Coly silt loams, hummocky, eroded
Ks	Kenesaw silt loam, 0 to 1 percent slopes
2KsA	Kenesaw silt loam, terrace, 1 to 3 percent slopes
Le	Leshara silt loam
2Le	Leshara silt loam, saline
Lx	Loamy alluvial land
M	Marsh
2Md	Meadin loamy sand, terrace, 0 to 2 percent slopes
2Mw	Meadin silt loam, terrace, 0 to 1 percent slopes
On	O'Neill fine sandy loam, 0 to 1 percent slopes
P	Platte soils
2PW	Platte-Wann complex, channeled
RB	Rough broken land, loess
Ru	Rusco silt loam
S	Spoil banks
Sc	Scott silt loam
2Th	Thurman loamy fine sand, terrace, 0 to 3 percent slopes
VcB	Valentine loamy sand
Wb	Wann fine sandy loam
Wm	Wann loam
2Wm	Wann loam, saline